

AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been broken down into sections.

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TITLE: Performance Evaluation Report for
Soil Vapor Extraction Operations at
Carbon Tetrachloride Site,
February 1992 – September 2000

EDMC#: 0055548

SECTION: 2 of 2

APPENDIX C

PASSIVE SOIL VAPOR EXTRACTION DATA

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PASSIVE SOIL VAPOR EXTRACTION DATA

This appendix contains data collected at passive soil vapor extraction (PSVE) systems operating on eight wells in the 216-Z-1A/Z-18 wellfield between October 1999 and September 2000. The eight PSVE systems are installed on wells 299-W18-6L, 299-W18-7, 299-W18-10L, 299-W18-11L, 299-W18-12, 299-W18-246L, 299-W18-247L, and 299-W18-252L. All eight PSVE systems are installed on wells with intervals open below the Plio-Pleistocene layer. Some well names include an "L" following the number to designate this lower interval (e.g., 299-W18-6L); these wells also have an interval open above the Plio-Pleistocene layer that would be designated by a "U" following the number (e.g., 299-W18-6U). In wells with two open intervals, the intervals are isolated by a downhole packer.

All eight PSVE systems include a removable cartridge of granular activated carbon (GAC) that is replaced monthly; samples of the GAC that was removed from the well are then sent to an offsite laboratory for analysis of carbon tetrachloride concentrations. In addition, three of the wells (299-W18-6L, 299-W18-247L, and 299-W18-252L) are instrumented to record flow, differential pressure, temperature, and carbon tetrachloride concentrations hourly. In these three wells, differential pressures are also monitored hourly in the well intervals open above the Plio-Pleistocene (299-W18-6U, 299-W18-247U, 299-W18-252U). A ninth well, 299-W18-9, has an interval open below the Plio-Pleistocene layer, is sealed to atmosphere, and serves as a control well. It is instrumented to record differential pressure and temperatures hourly. In wells 299-W18-6L, 299-W18-247L, 299-W18-252L, and 299-W18-9, temperatures are measured at 3 m and 61 m below the top of the well. Differential pressures are also monitored hourly at three stainless steel tubes open at depths above, between, and below the two screens on well 299-W18-252 and at five soil vapor probes installed above the Plio-Pleistocene layer at CPT-4F.

The PSVE systems are described in Section 3.0 of this report. Evaluation of the data is provided in Section 5.7 of this report. The locations of the PSVE systems and associated differential pressure monitoring are shown in Figure 5-41.

The following data are included in this appendix:

- Carbon tetrachloride concentrations monitored hourly at the three instrumented PSVE systems (Figures C-1 through C-3)
- Comparisons of flows and differential pressures monitored hourly at the three instrumented PSVE systems (Figures C-4 through C-6)
- Temperatures monitored hourly at the three instrumented PSVE systems and at the sealed control well (Figures C-7 through C-10)

Appendix C – Passive Soil Vapor Extraction Data

- Monthly comparisons of carbon tetrachloride concentrations monitored hourly at the three instrumented PSVE systems (Figures C-11 through C-22).
- Sample collection and analysis data for the GAC cartridges at the eight PSVE systems (Tables C-1 through C-20)
- Volume of water drained from GAC cartridges and hoses during sample collection at the eight PSVE systems (Table C-21)
- Passive soil vapor extraction well network parameter and instrumentation (Table C-22)
- Summary of contaminant concentrations, temperatures, pressures, and flowrates measured during passive soil vapor extraction (Tables C-23 and C-24)

C.1 MONTHLY GAC CARTRIDGE SAMPLING AND ANALYSIS

The following method is used to collect samples from the passive GAC sample cartridges:

1. Upon arrival, collect all 8 previously-prepared sample cartridges stored at the site. Each of the cartridges has been assigned to a specific well and labeled accordingly. At each of the passive well sites, replace the in-line cartridge with the corresponding cartridge of clean GAC.
2. Sample each of the removed cartridges by pouring the GAC into a plastic bag. Weigh the used GAC from the cartridge and record the weight. Using a sterile scoop, mix the GAC in the bag thoroughly and fill sample jars with sample media. The sample jar size is 250 mL.
3. Fill the cartridge with approximately 0.45 kg (1 lb) of clean GAC. Weigh the clean GAC used to fill the cartridge and record the weight.
4. Store the re-filled clean cartridges for use during the next sampling event the following month.

The volume of drainable water contained in the used GAC cartridges and/or in the PSVE hoses is estimated and recorded by the sampler. Routine inspection by the soil vapor extraction system operator also resulted in occasional water drainage from the PSVE hoses.

The sampling is performed in accordance with the following procedures:

- BHI-EE-01, Procedure 1.5 "Field Logbooks"
- BHI-EE-01, Procedure 3.0 "Chain of Custody"
- BHI-EE-01, Procedure 3.1 "Sample Packaging and Shipping"
- BHI-EE-01, Procedure 4.4 "Container Sampling."

Appendix C – Passive Soil Vapor Extraction Data

At the off-site laboratory, a subsample of the GAC sample is used for analysis. Initially, two methods were selected for analysis of carbon tetrachloride on the GAC: bomb combustion to obtain a total volatile organic compound (VOC) concentration (i.e., total chloride concentration) and traditional volatile organic analysis (VOA) (SW-846 method 8260) to obtain individual VOC concentrations. The purpose of selecting two methods was to evaluate whether the traditional method was detecting all of the VOC by comparing the total VOC concentration to the sum of the individual VOC concentrations. The laboratory also provides % moisture for each sample.

Based on initial analytical results, the bomb combustion method was discontinued. Because of the water content on the GAC, the laboratory was unable to get the GAC to burn consistently. In the October 1999 analytical results, low total chloride results correlate to GAC noted to be wet at time of sampling (Tables C-1 and C-2). In addition, the high carbon tetrachloride concentrations detected by the traditional VOA method suggested that the traditional VOA method (which does not have a low detection limit) would be adequate to analyze the samples. Therefore, the bomb combustion method was not retained for analysis of the GAC.

Because of the high carbon tetrachloride concentrations, the VOA method was modified to be "medium level." In the medium-level method, methanol is used to extract carbon tetrachloride from the GAC. This approach improves the consistency of the laboratory results and avoids overwhelming the gas chromatograph with high concentrations. Although using methanol may result in a more thorough removal of the carbon tetrachloride for analysis, it also results in dilution of the sample. Dilution of the sample may explain the results for chloroform being below the detection limit in later analyses.

The mass of carbon tetrachloride on each cartridge of GAC is calculated according to the following method:

1. Receive laboratory values based on as-received material:
 - a. carbon tetrachloride concentration as (micrograms of CCl_4)/(kilograms of GAC) in aliquot, where the GAC in the aliquot consists of GAC and water;
 - b. percent solids as (kg of dry GAC)/(kilograms of GAC and water)
2. Divide the carbon tetrachloride result by the percent solids, providing (micrograms of carbon tetrachloride)/(kilograms of dry GAC)
3. Multiply by the dry weight of clean GAC in the cartridge measured by the sampler, providing (micrograms of carbon tetrachloride)

Grams of carbon tetrachloride = (ug CCl_4)/(kg GAC+water) * (kg GAC+water)/(kg dry GAC) * (kg dry GAC) * (1 g/10⁶µg).

C.2 HOURLY WELLHEAD SAMPLING AND ANALYSIS

Three of the eight wells used for passive extraction (299-W18-6L, 299-W18-247L, 299-W18-252L) are also instrumented to record hourly data (flow, differential pressure, temperature, and carbon tetrachloride concentrations). The flow, pressure, and temperature data are recorded on Campbell dataloggers; the carbon tetrachloride concentrations are stored in the memory of the B&K sensors. The hourly data are downloaded from the dataloggers and from the B&Ks every 2 to 4 weeks. The instruments are powered by line power. The flow meters measure flow in 1.2-m (4-ft) lengths of 10.2-cm (4-in.)-diameter PVC pipe built in-line with the flexible hoses (Figure 3-3). Twelve additional locations in the 216-Z-1A/Z-18 well field are instrumented to measure hourly differential pressure and/or temperature data that is recorded on a datalogger, downloaded every 2 to 4 weeks, and powered by line power. The instrumentation used at these locations is identified in Table C-22.

At each of the three instrumented wells, a sampling pump is used to pull a vapor sample from the wellhead for analysis by the B&K to protect the internal pump in the B&K from pulling against the downhole differential pressure. The sampling pump releases the vapor sample into a buffer jar which has a narrow diameter tube to atmosphere to maintain ambient pressure in the sample chamber. The internal pump on the B&K samples from the buffer jar.

The datalogger is programmed to turn on the sample pump to sample the well at 2 minutes before the hour. The datalogger is programmed to turn off the sample pump at 5 minutes after the hour. After downloading the B&K, the sampler turns on the B&K at a time close to, but after, 5 minutes after the hour (e.g., 6 minutes after the hour). The B&K is programmed to sample every 60 minutes after that (in this example, theoretically always sampling at 6 minutes after the hour). However, the B&K internal clock loses time at a rate of approximately 7 minutes every 2 weeks.

The datalogger is programmed to measure temperature, pressure, and flow every ten seconds and to save the data in an intermediate memory. At the end of each hour, the data are averaged and the result recorded as a single data point for that hour.

To calculate the mass removed using the flow and concentration data, the B&K data must be assigned to the top of the hour to be associated with the corresponding flow data. Because of the drifting B&K clock, the following rule was used to assign B&K data to a particular hour: If the B&K analysis is recorded at a time later than 2 minutes before the hour and earlier than 2 minutes before the following hour, the data is assigned to that hour. For example, data collected between 9:58 and 10:58 is assigned to 10:00.

In January 2000, it was discovered that at well 299-W18-247L, the sample tube length had been entered into the B&K as 0 ft. instead of 10 ft. The sample tube length affects the purge time for the sample loop (the B&K calculates the purge volume/time based in part on sample tube length). Between October 1999 and January 2000, carbon tetrachloride concentrations recorded at this well were very low. After January 2000 concentrations became detectable and followed a typical venting well pattern (rising and falling with barometric pressure fluctuations). Therefore,

concentration data collected prior to correcting the parameter in the B&K computer have been disregarded as unrepresentative.

The mass of carbon tetrachloride removed is calculated based on the following formula:

$$\text{grams of carbon tetrachloride} = X \text{ ppmv} * Y \text{ ft}^3/\text{min} * 60 \text{ min/hr} * 1 \text{ hr} * (1/E+06) * 153.84 \text{ g/mol} * 1 \text{ mol}/22.4 \text{ L (0 oC, 1 atm)} * 273 \text{ oK}/298 \text{ oK} * 28.32 \text{ L/ft}^3$$

Figure C-1. Carbon Tetrachloride Concentrations Monitored Hourly at Well 299-W18-6L.

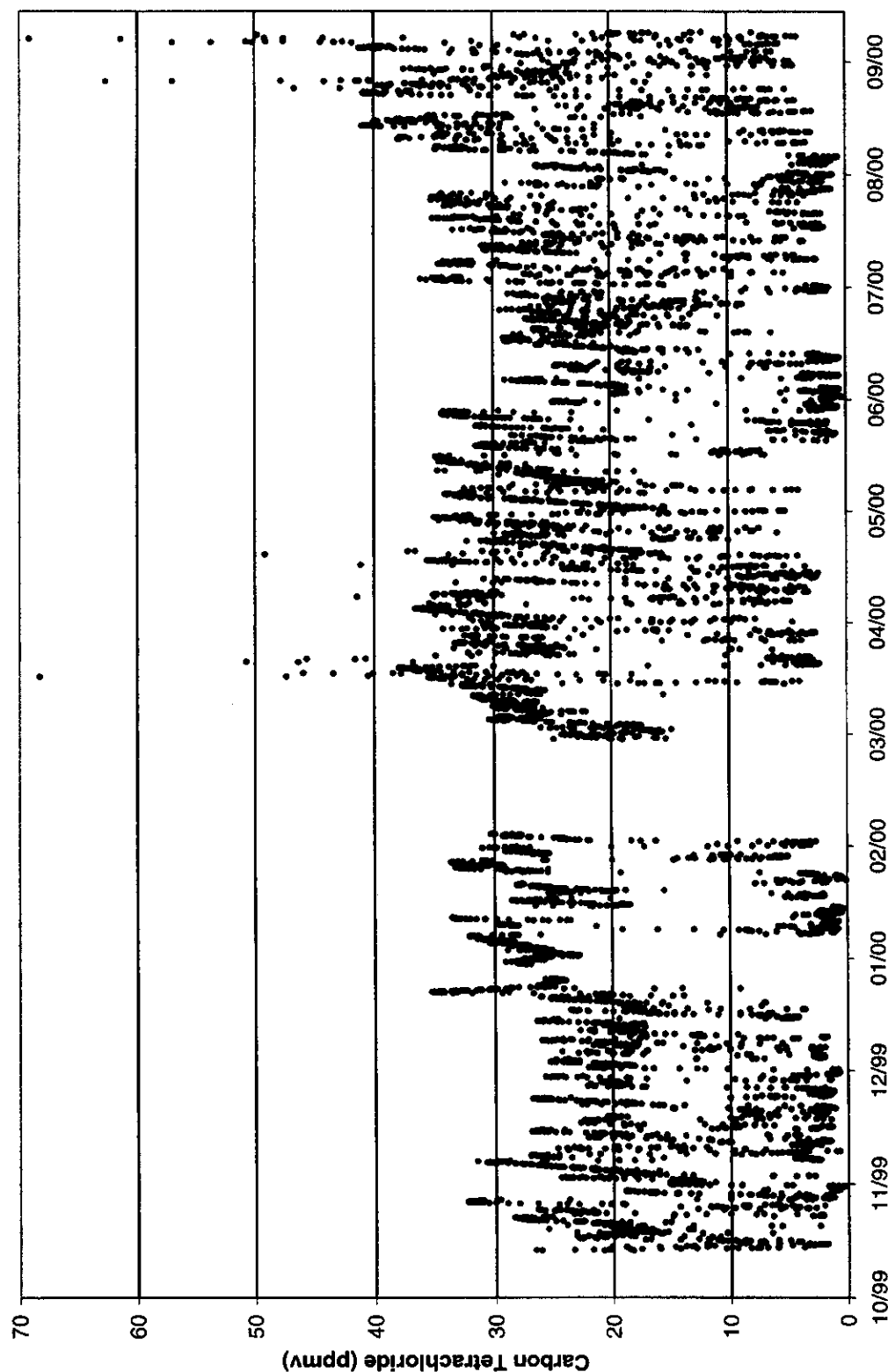


Figure C-2. Carbon Tetrachloride Concentrations Monitored Hourly at Well 299-W18-247L.

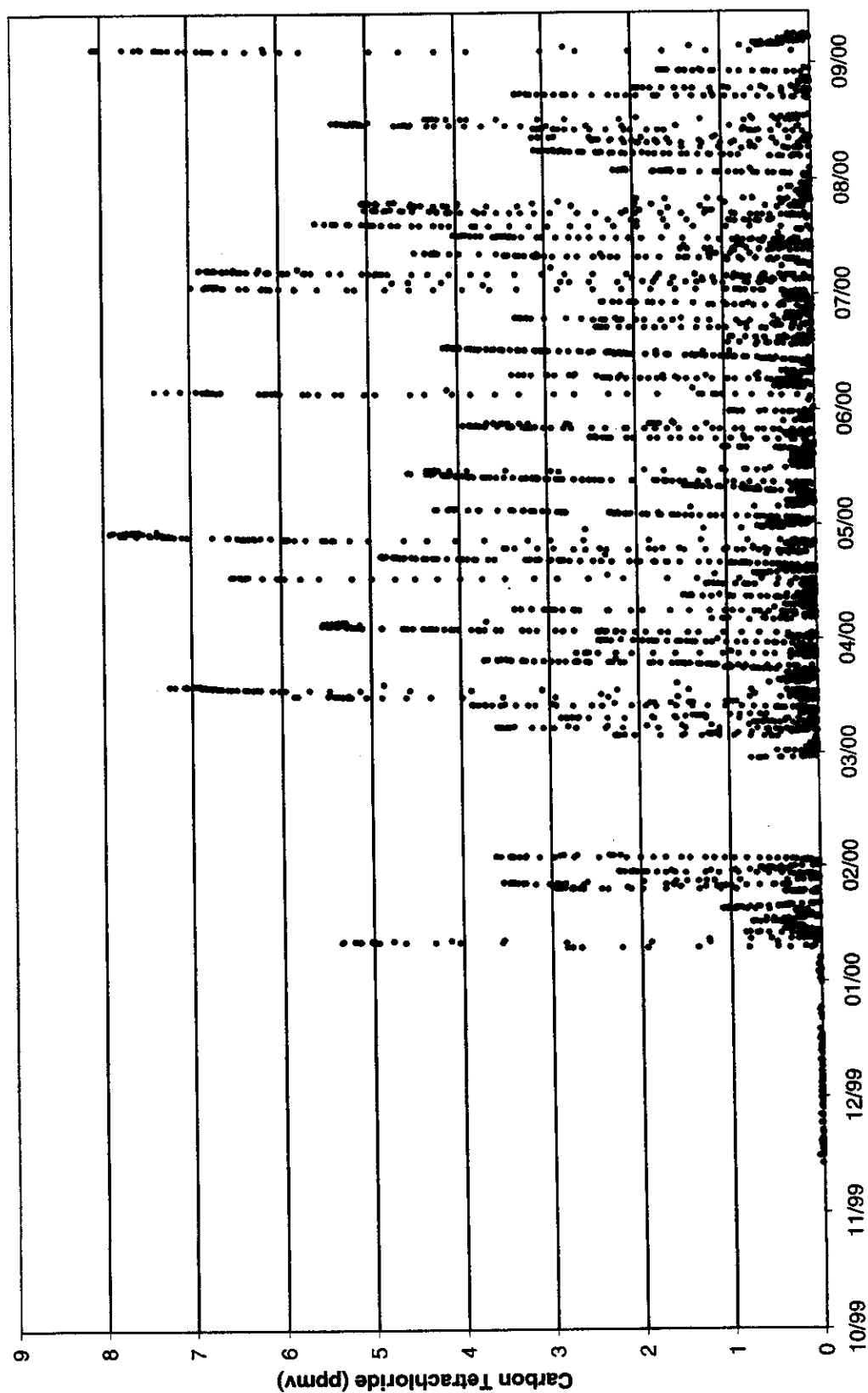


Figure C-3. Carbon Tetrachloride Concentrations Monitored Hourly
at Well 299-W18-252L.

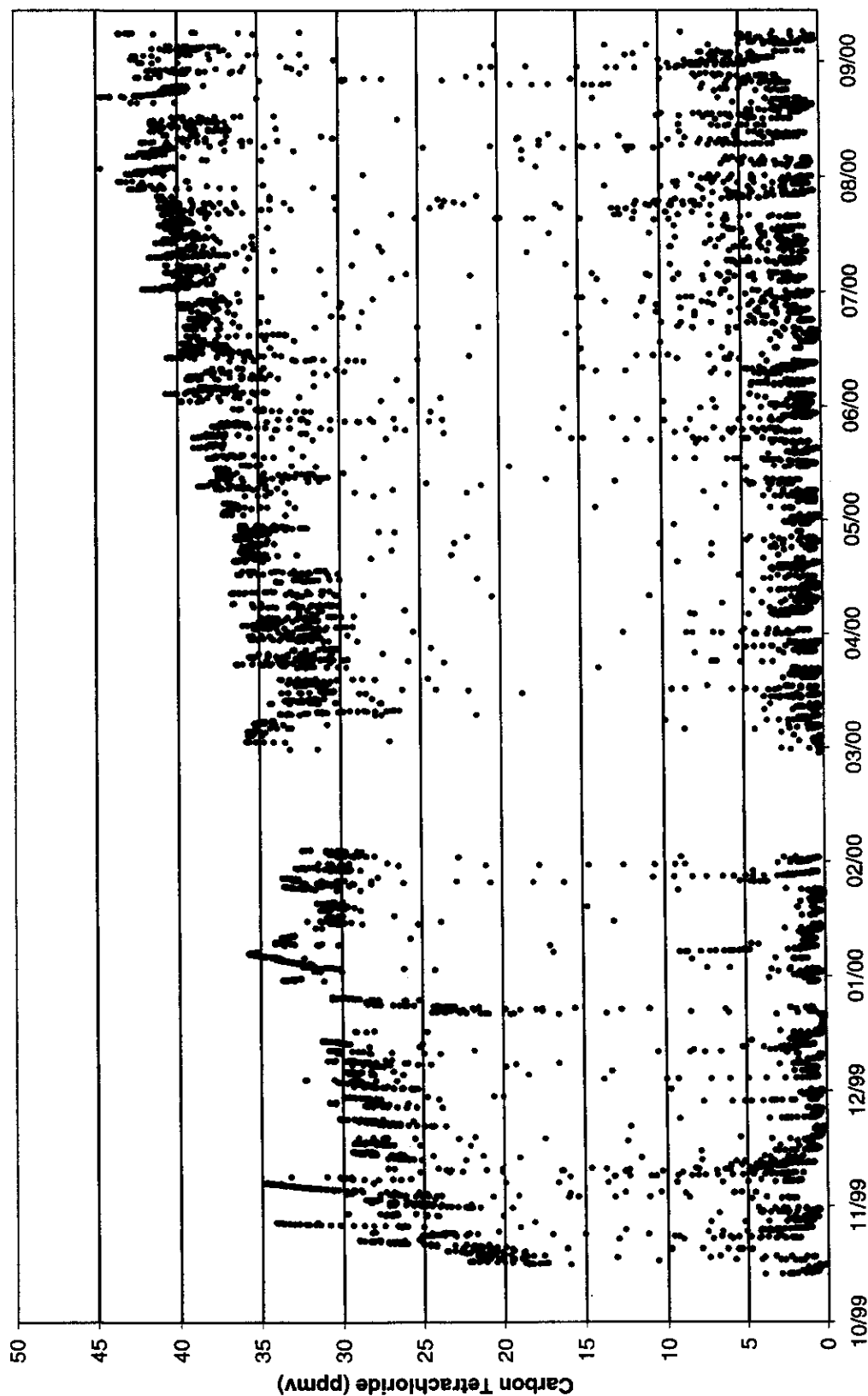


Figure C-4. Comparisons of Flows and Differential Pressures Monitored Hourly at Well 299-W18-6L.



Figure C-5. Comparisons of Flows and Differential Pressures Monitored Hourly at Well 299-W18-247L.

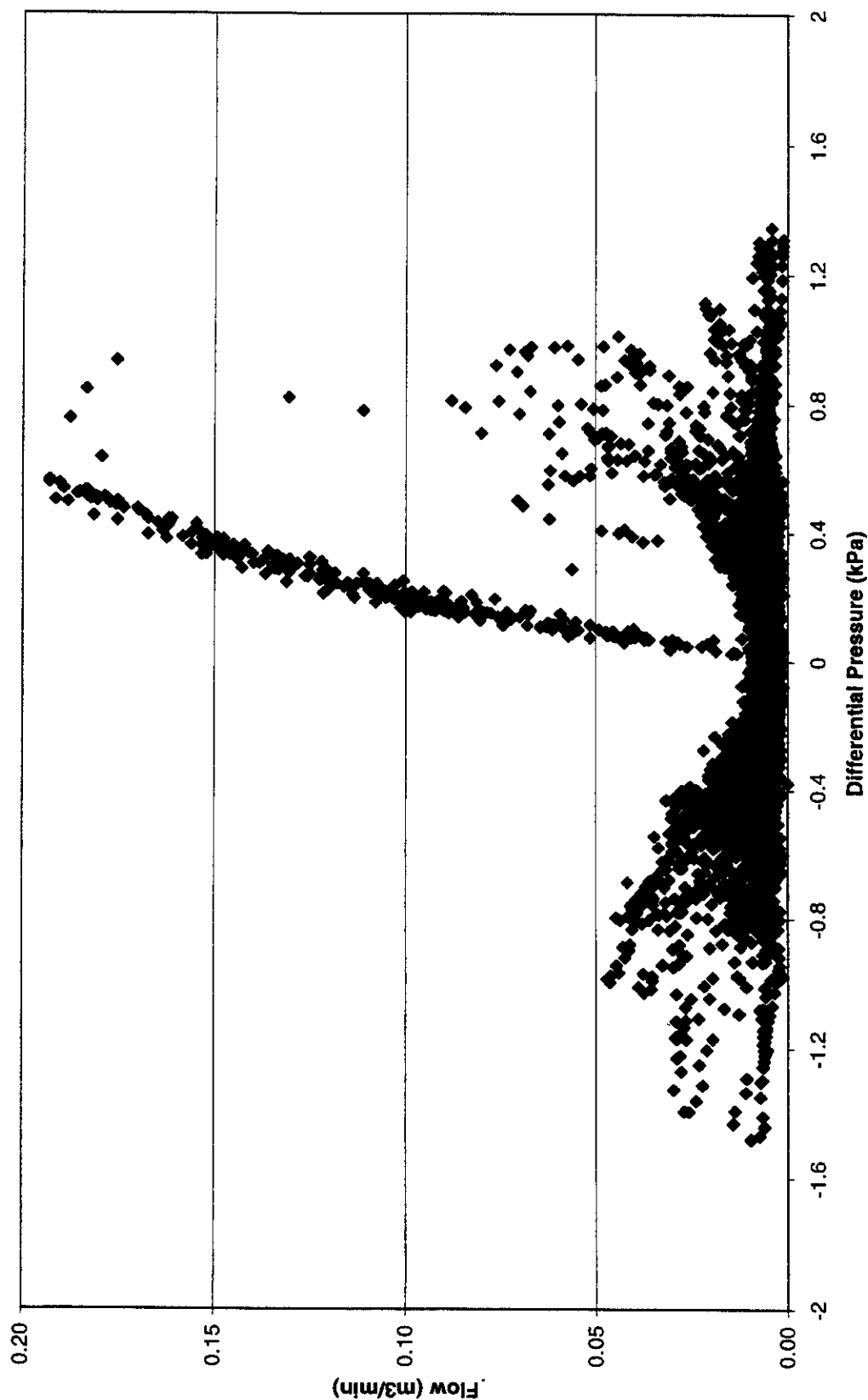


Figure C-6. Comparisons of Flows and Differential Pressures Monitored Hourly at Well 299-W18-252L.

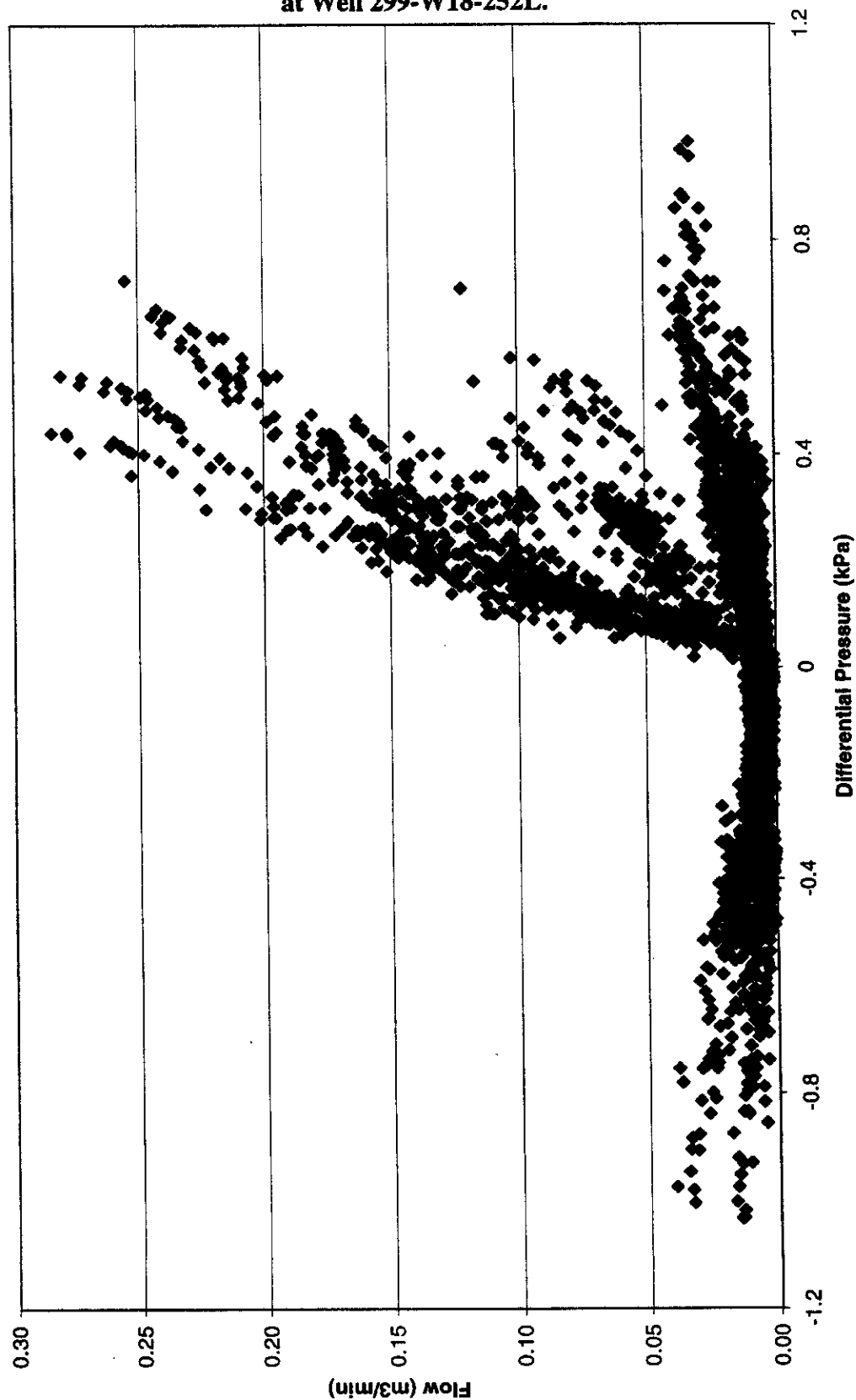


Figure C-7. Temperatures Monitored Hourly at
Top and Bottom of Well 299-W18-6L.

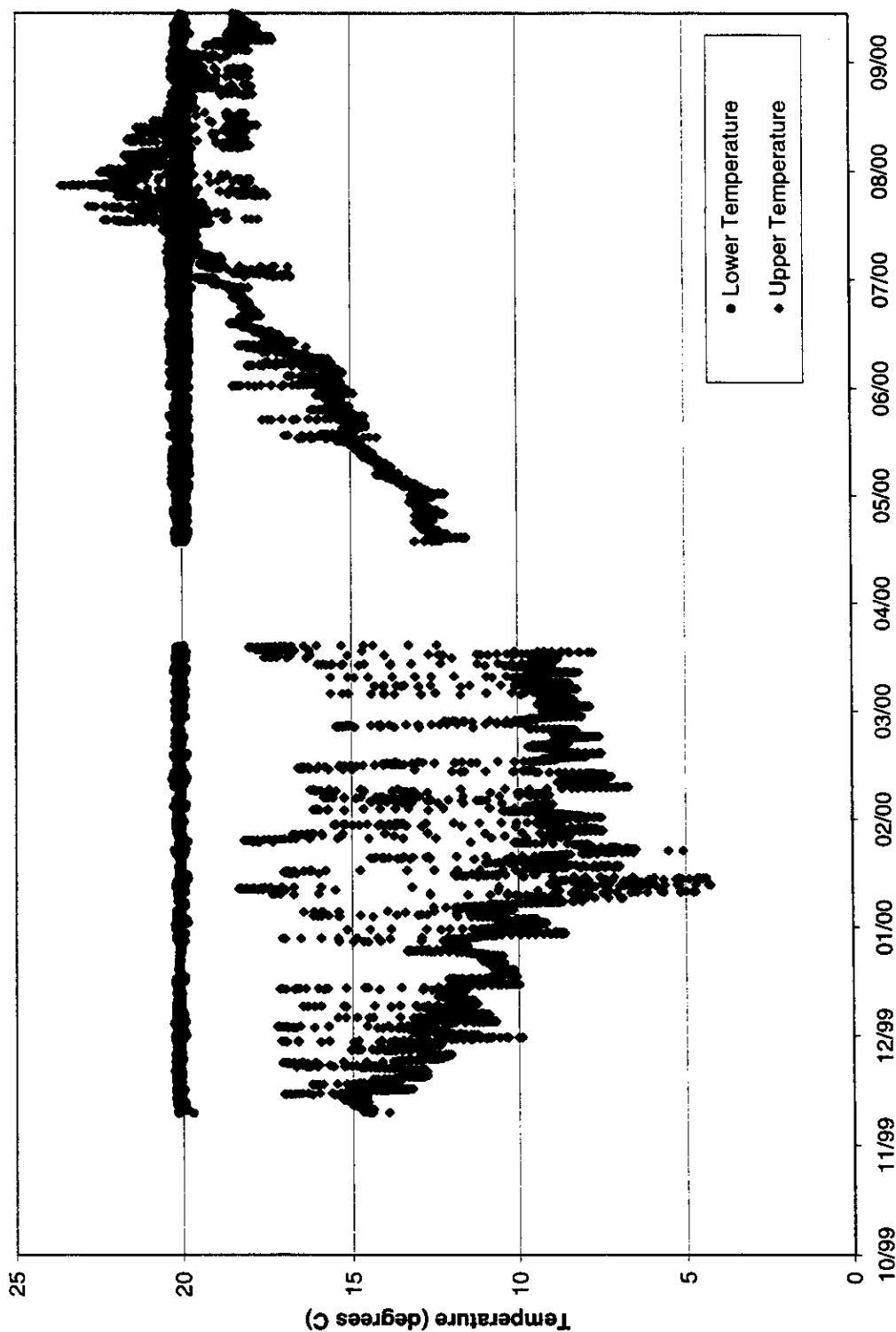


Figure C-8. Temperatures Monitored Hourly at
Top and Bottom of Well 299-W18-247L.

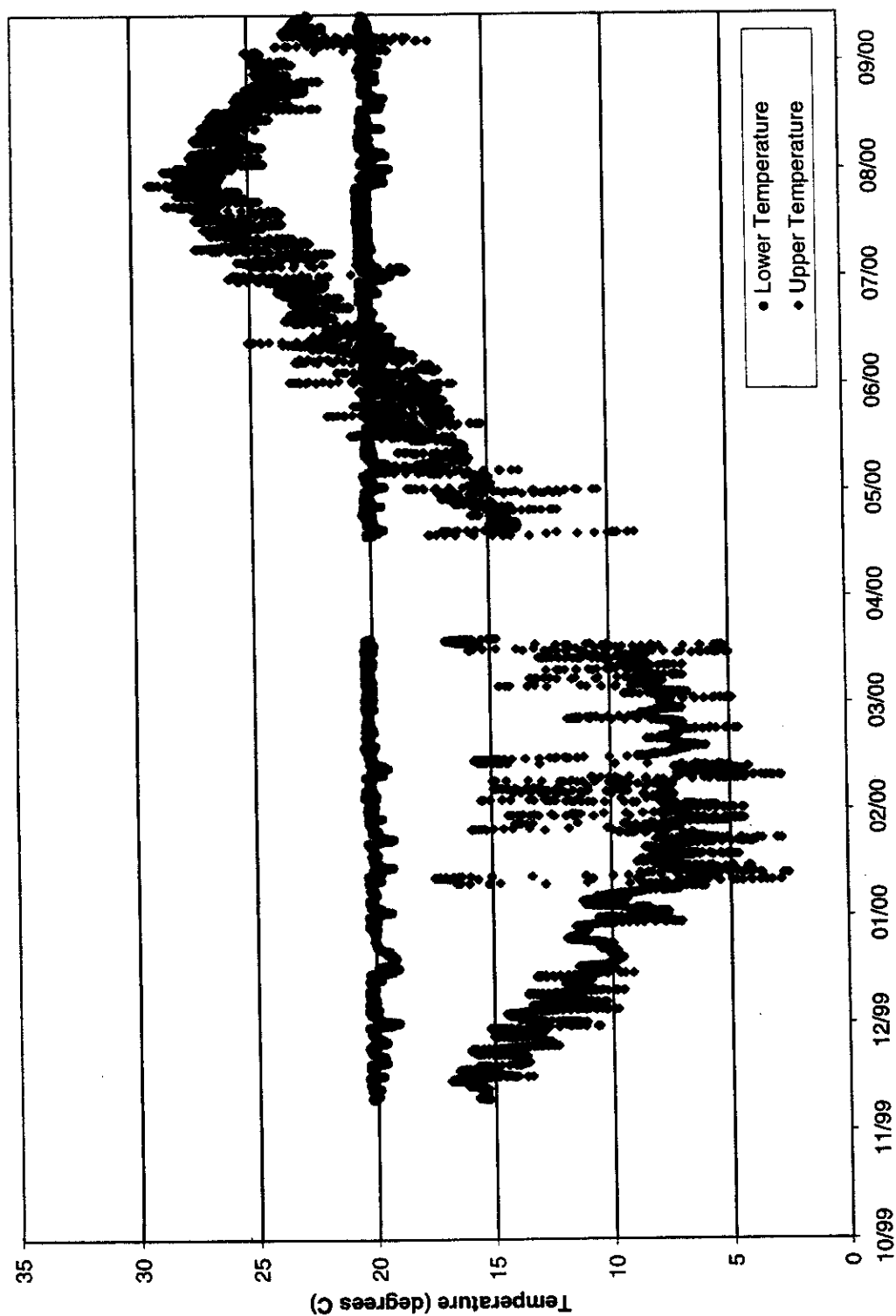


Figure C-9. Temperatures Monitored Hourly at Top and Bottom of Well 299-W18-252L.

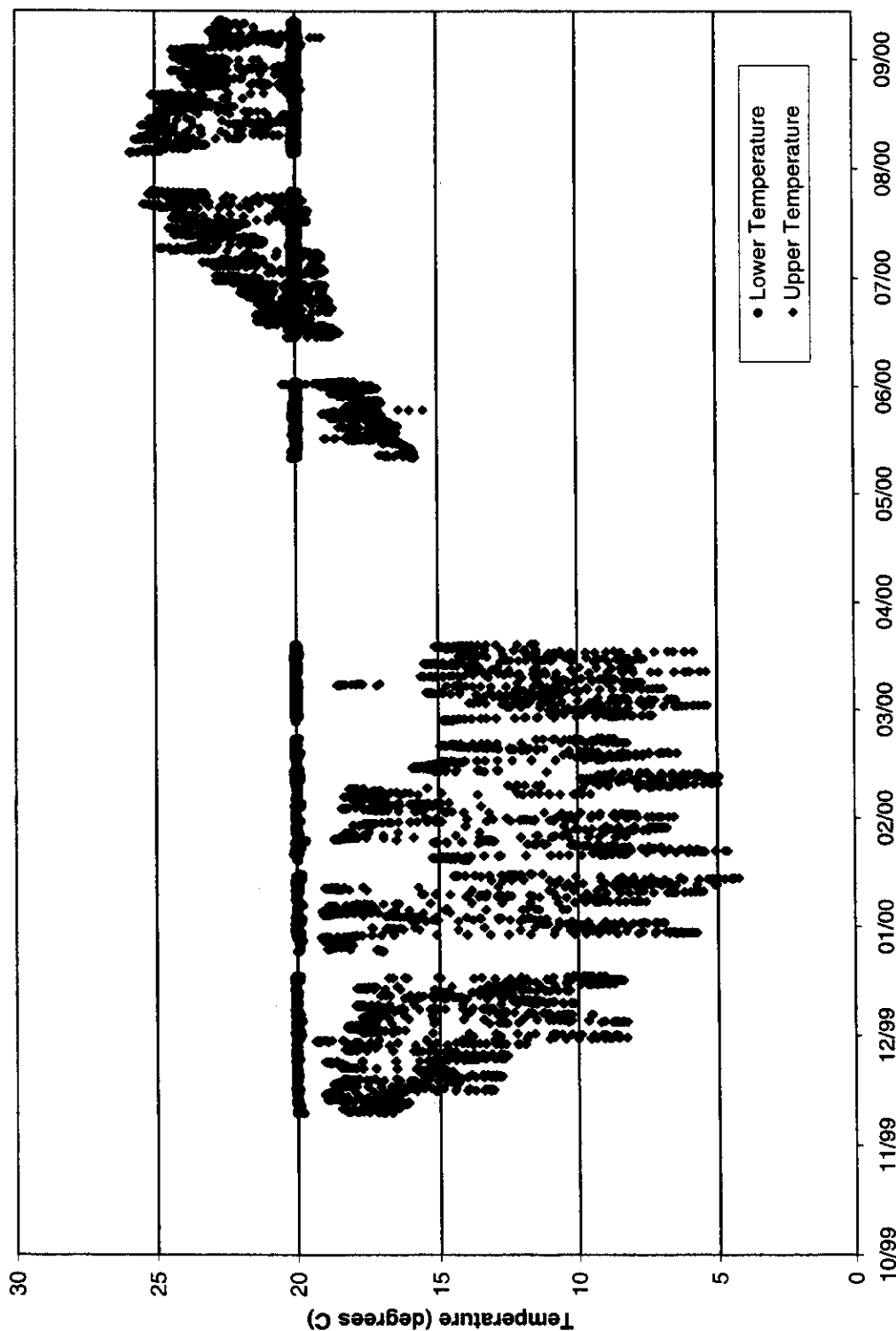


Figure C-10. Temperatures Monitored Hourly at Top and Bottom of Well 299-W18-9.

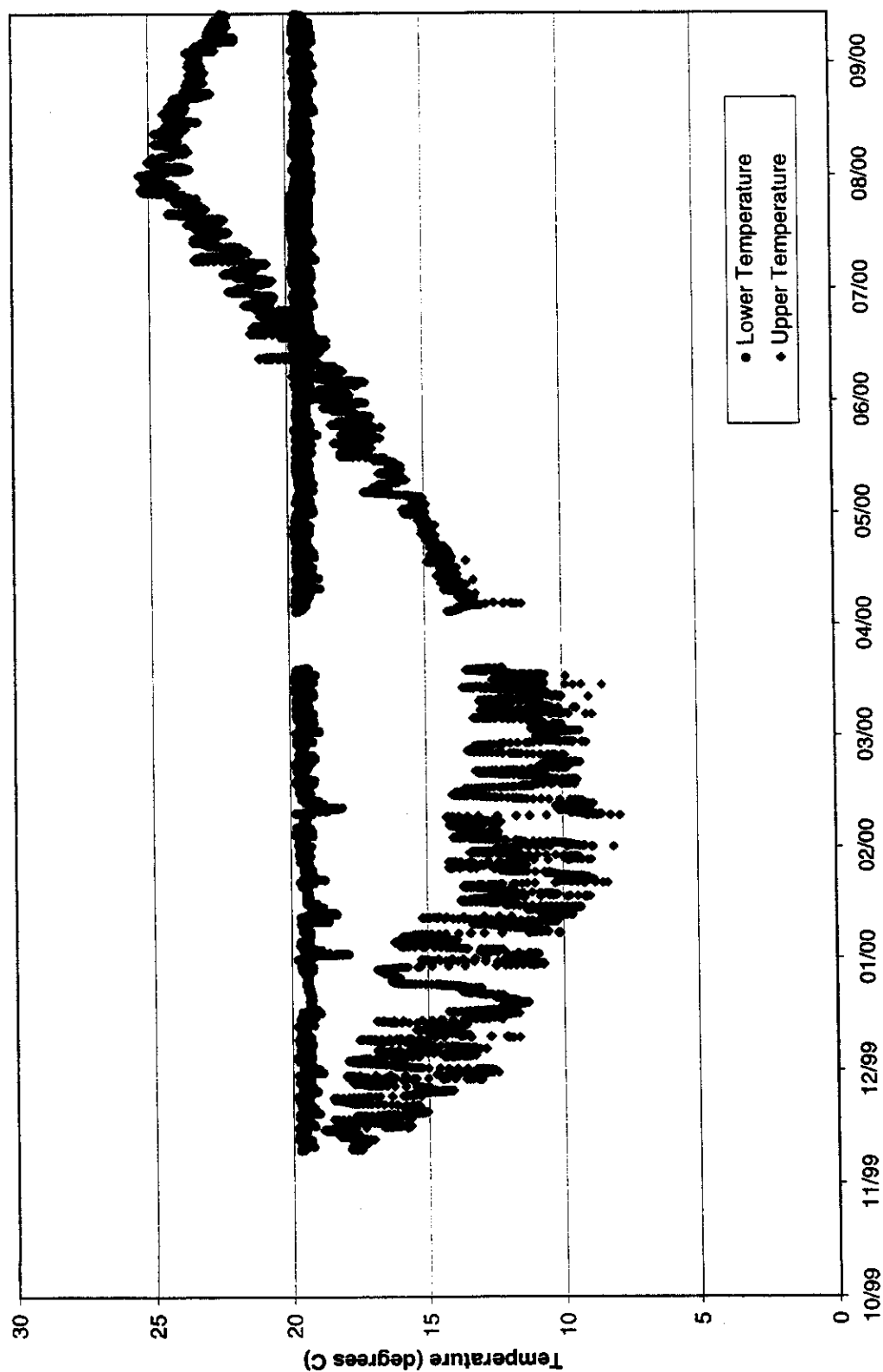


Figure C-11. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, October 1999.

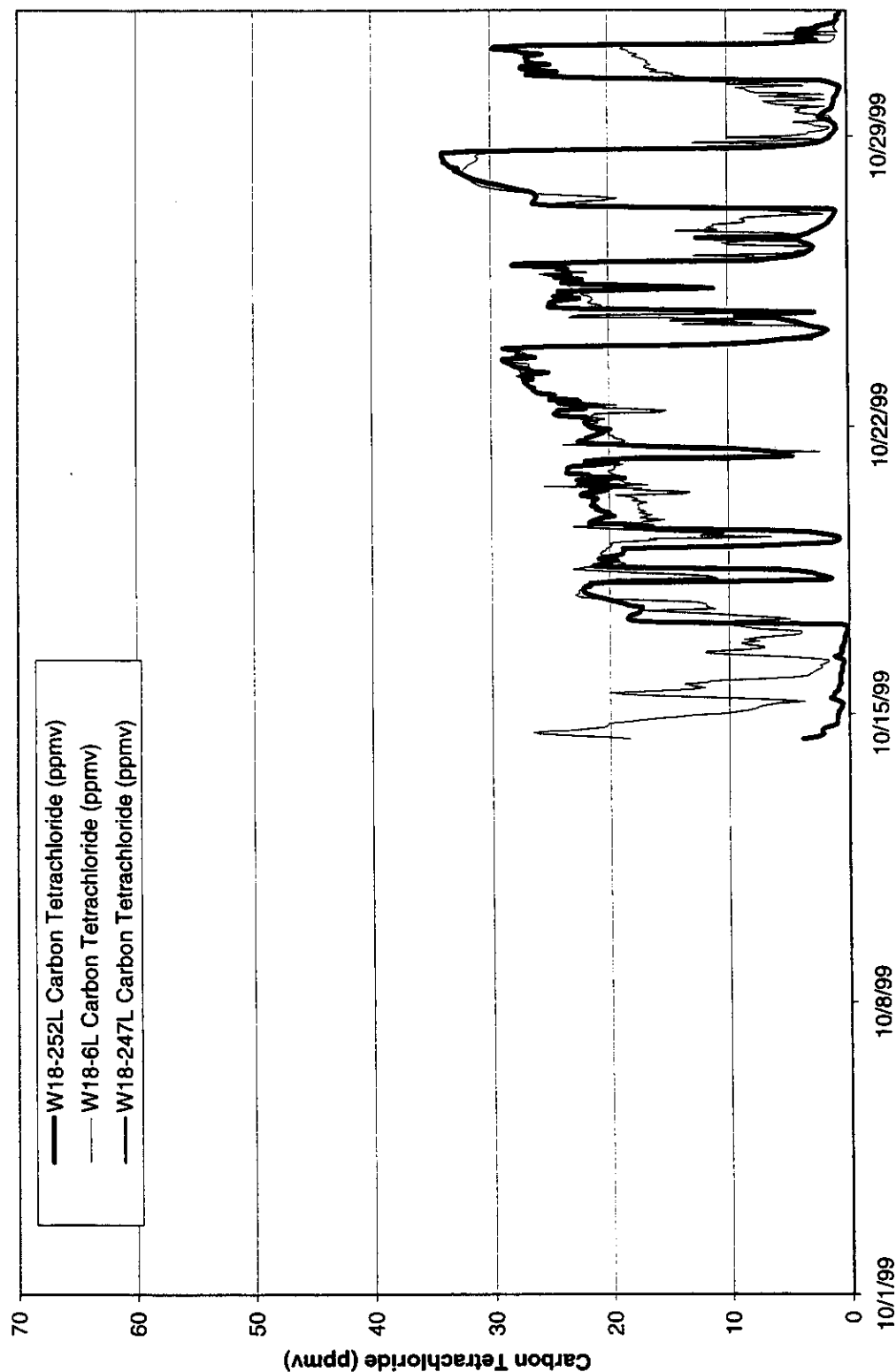


Figure C-12. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, November 1999.

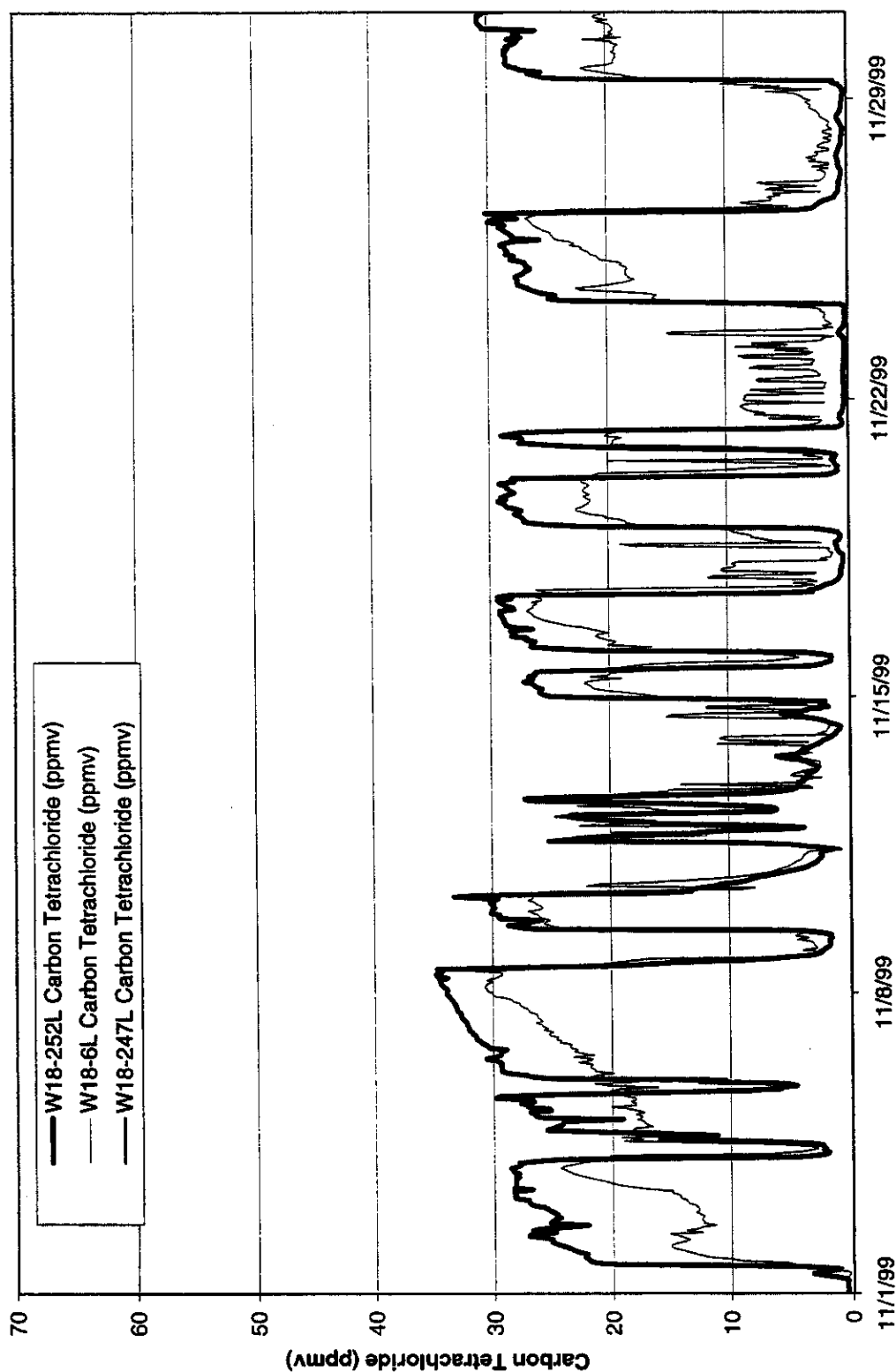


Figure C-13. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, December 1999.

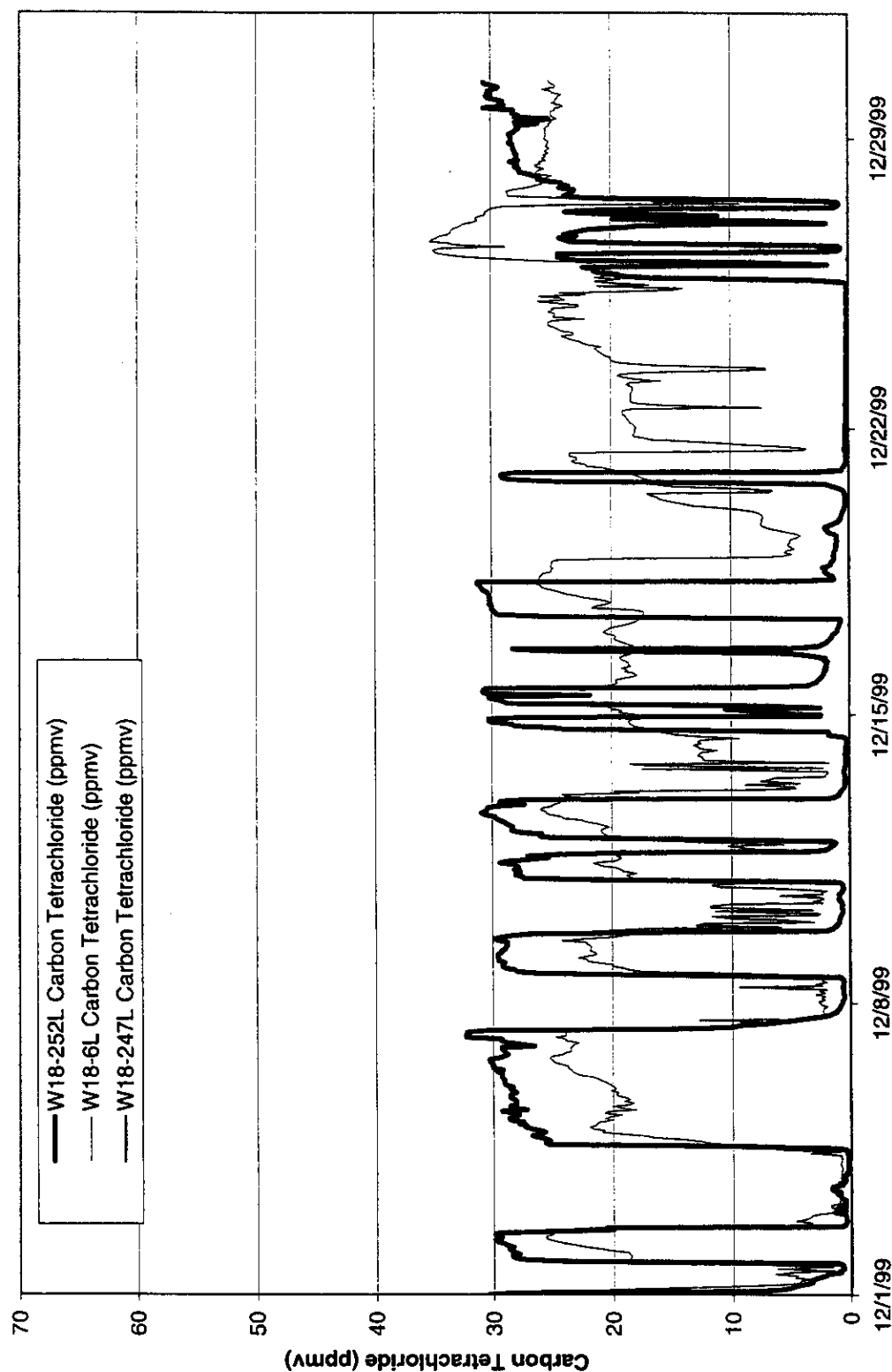


Figure C-14. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-274L, and 299-W18-252L, January 2000.

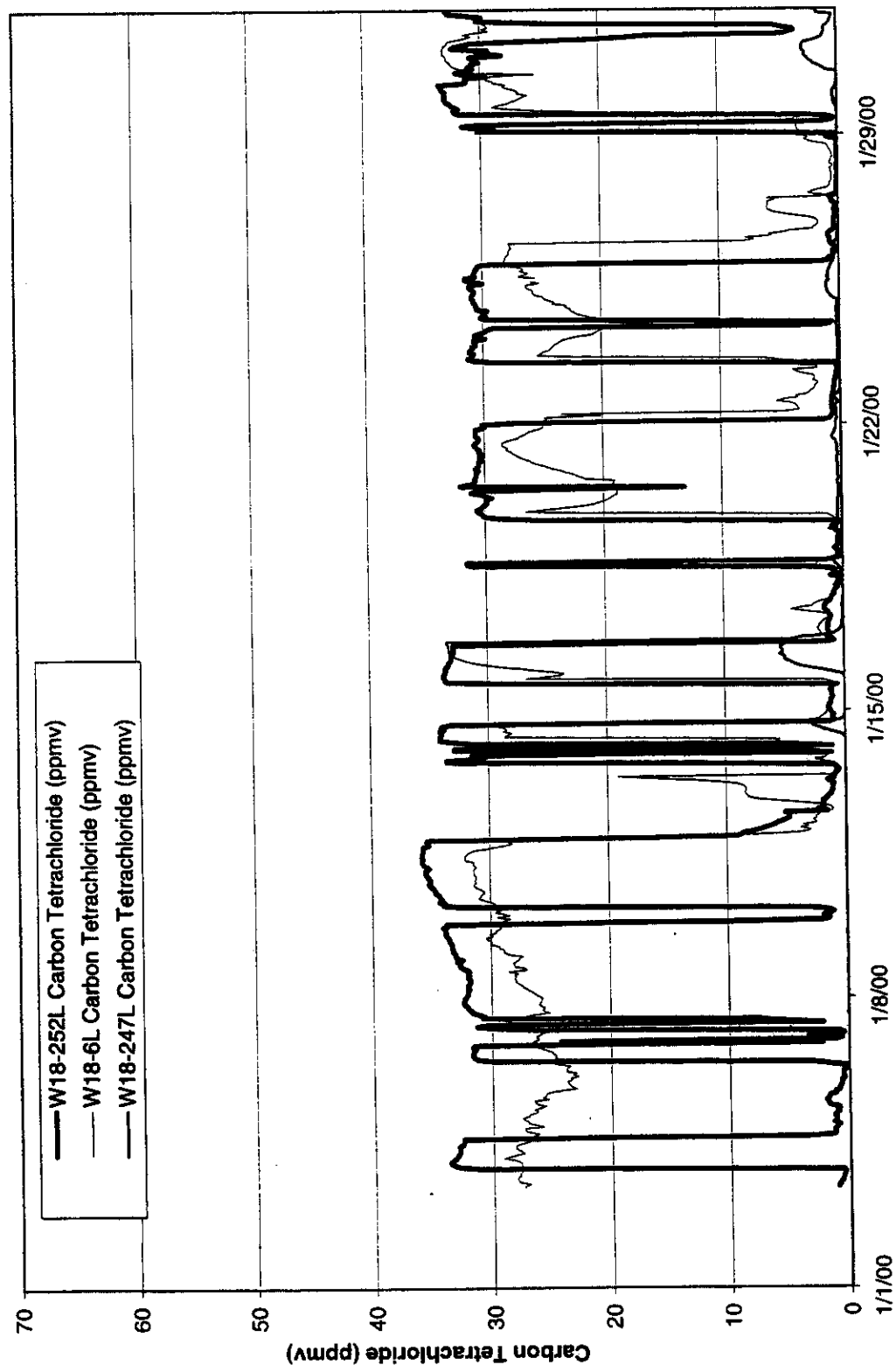


Figure C-15. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, February 2000.

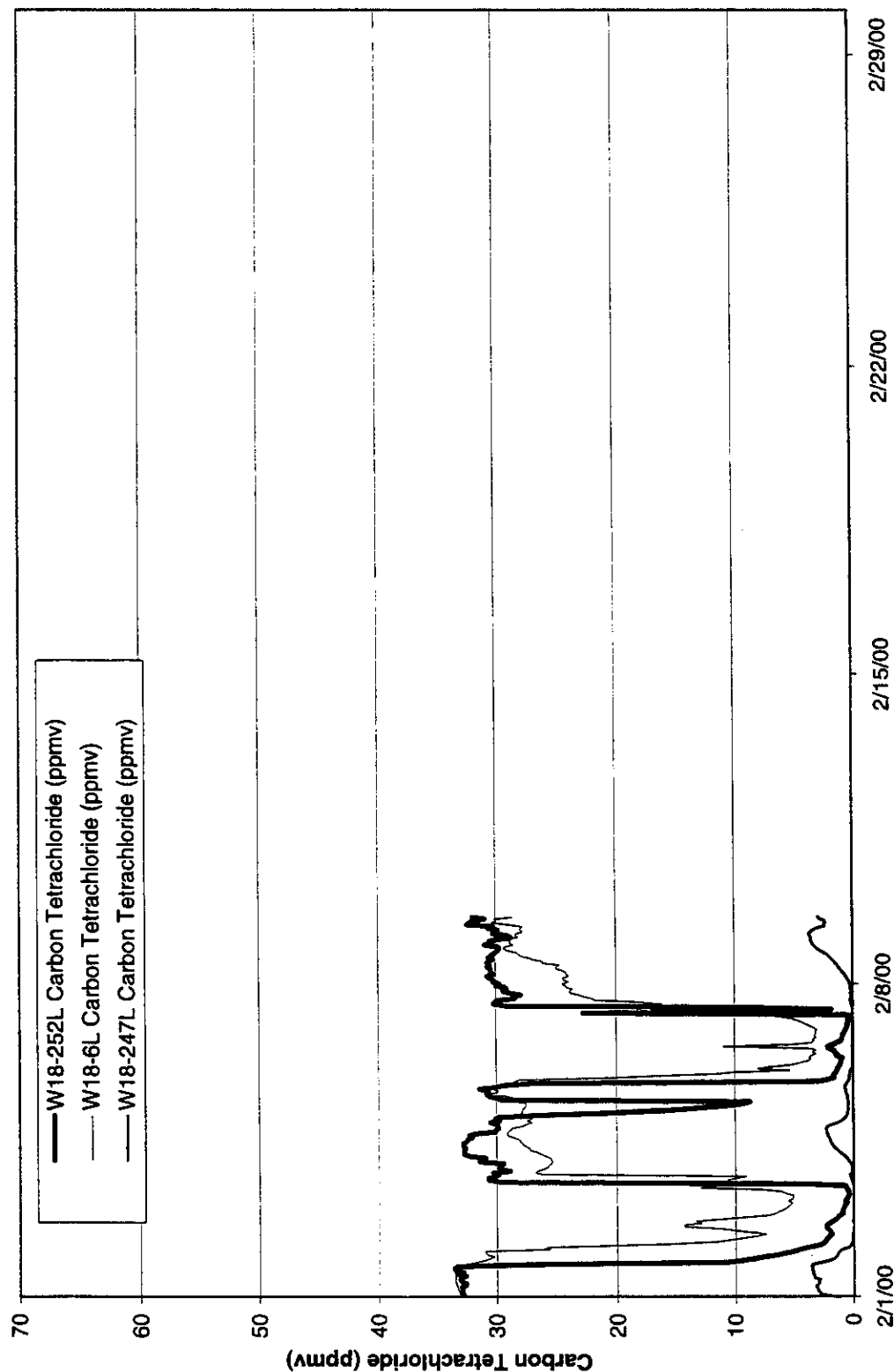


Figure C-16. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, March 2000.

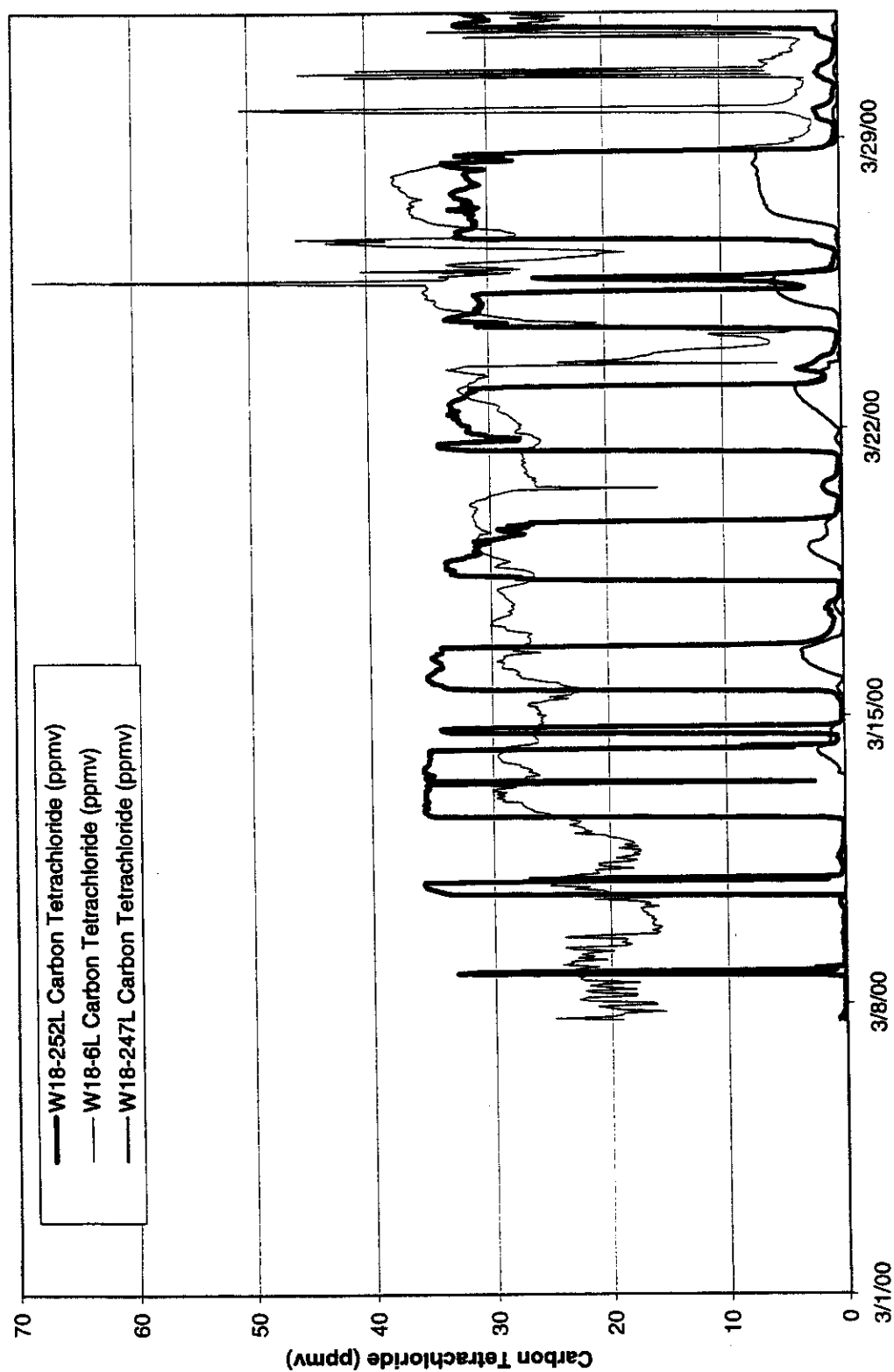


Figure C-17. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, April 2000.

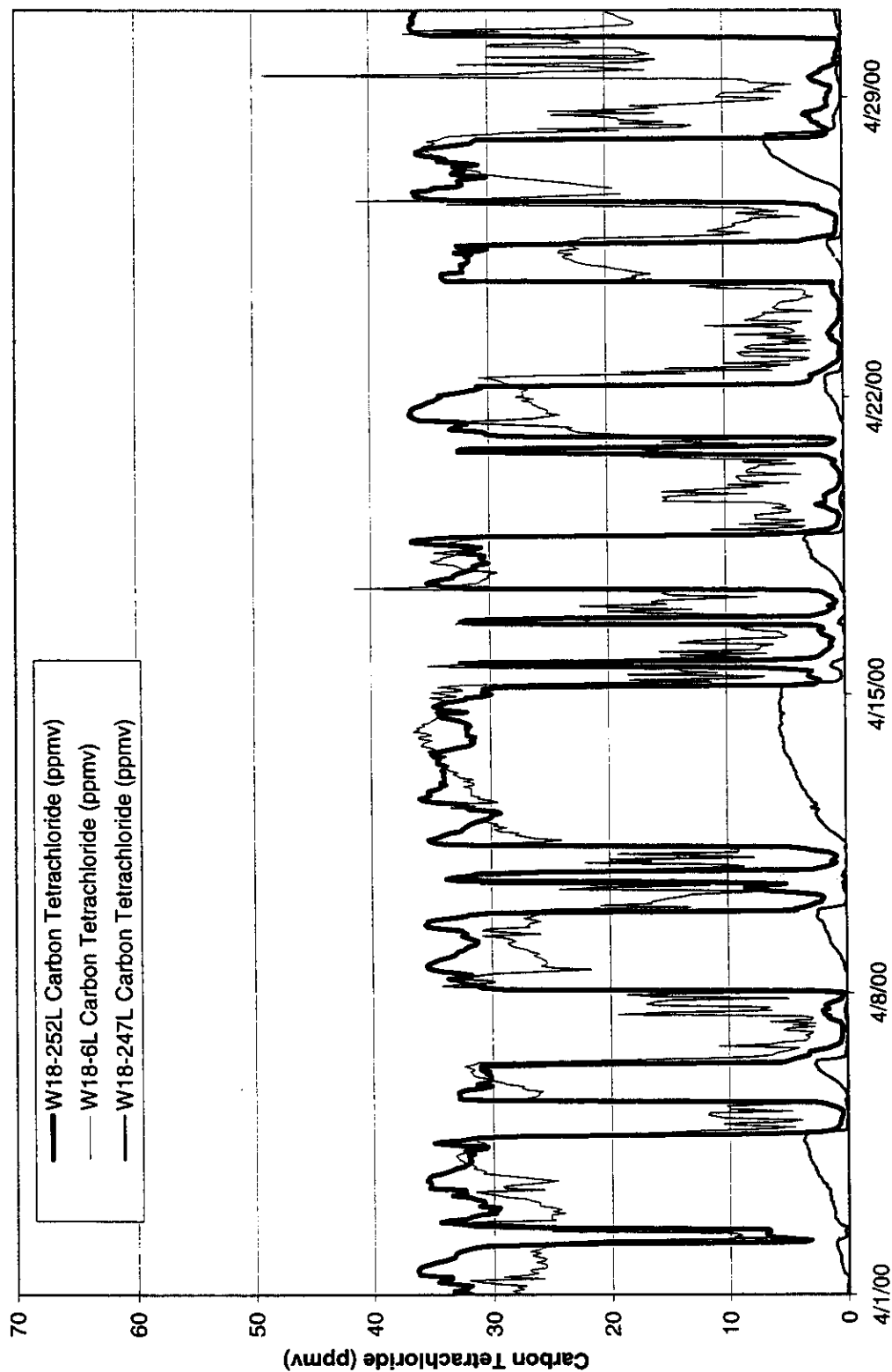


Figure C-18. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, May 2000.

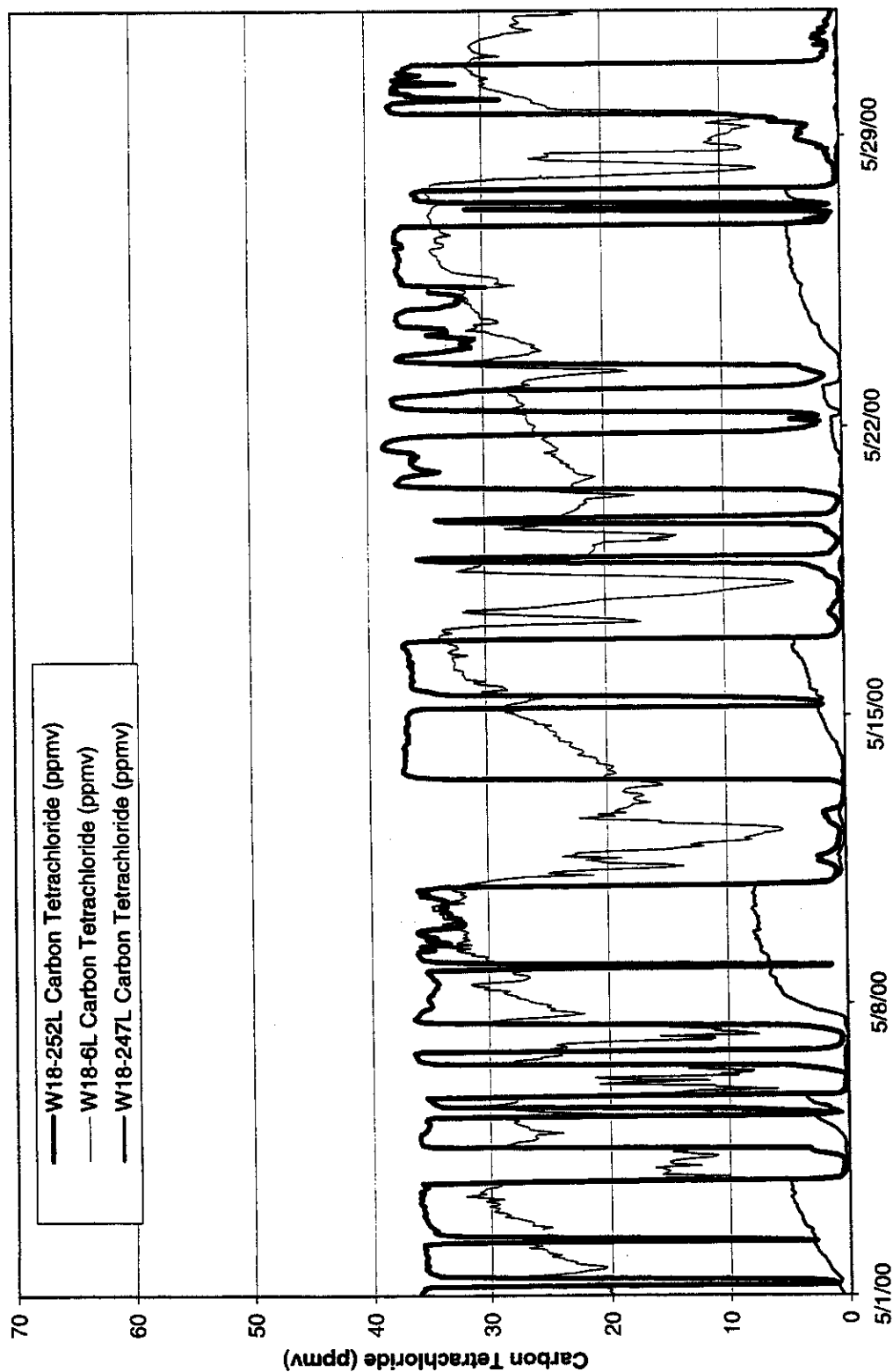


Figure C-19. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, June 2000.

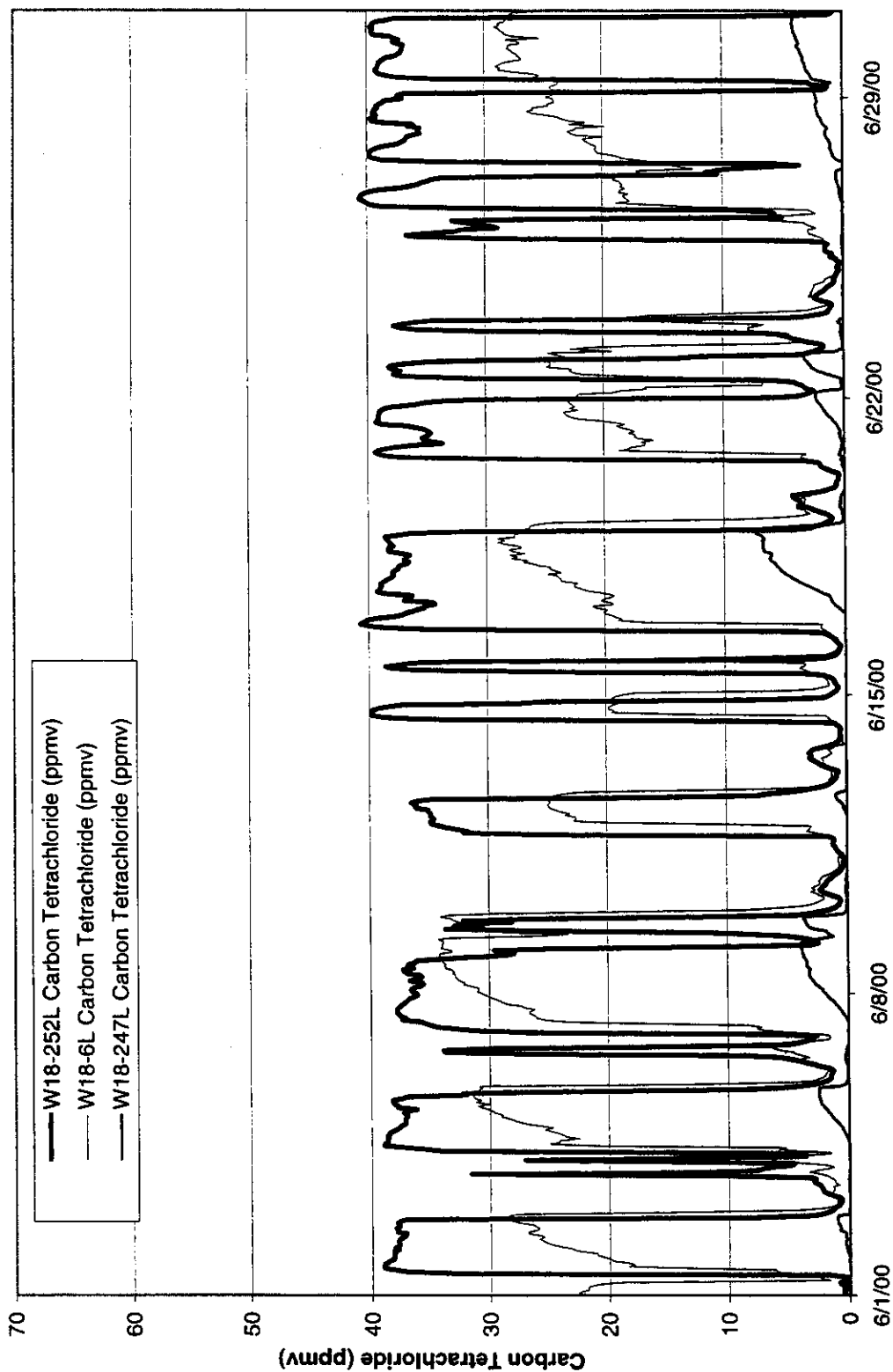


Figure C-20. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, July 2000.

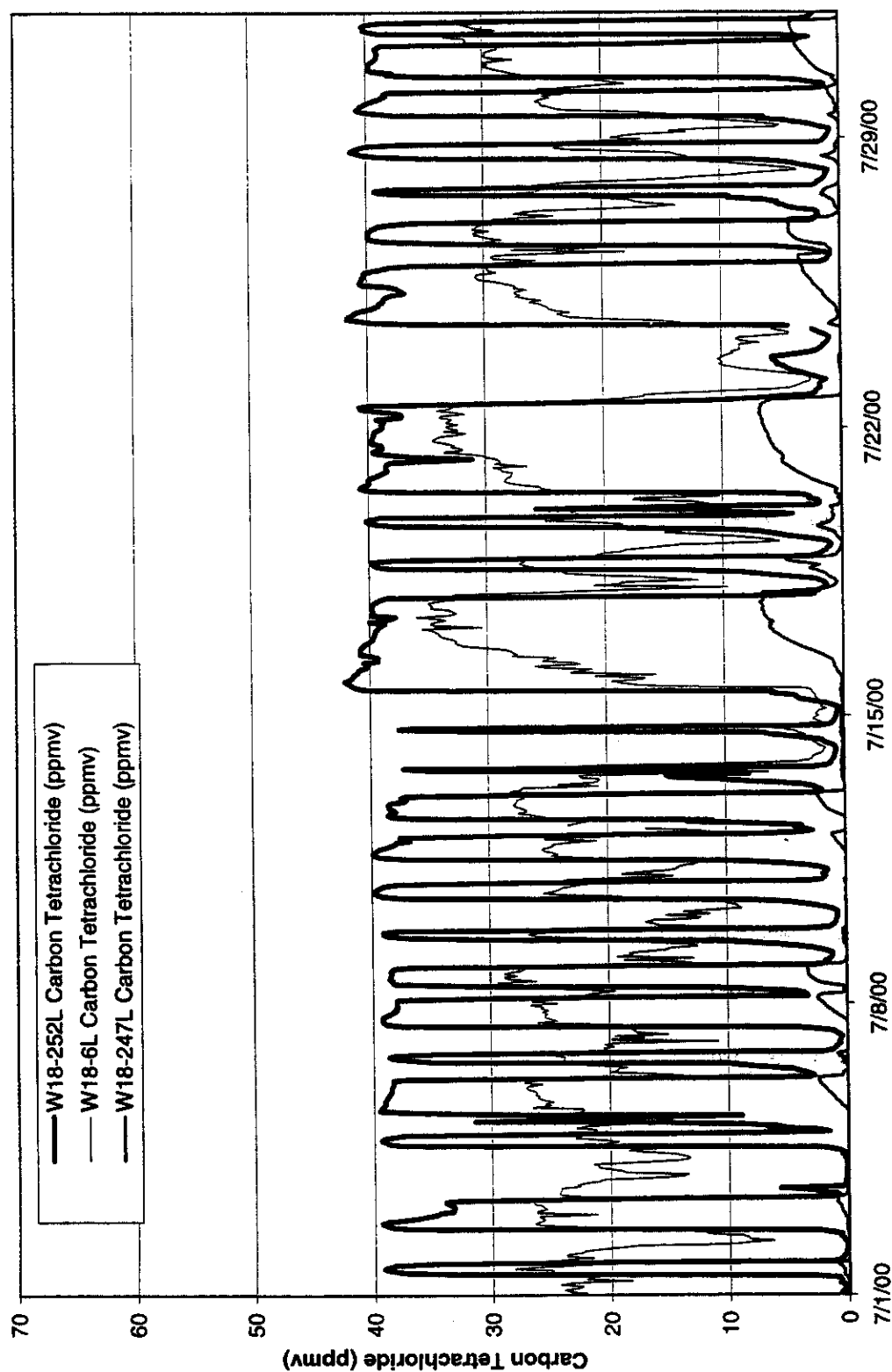


Figure C-21. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, August 2000.

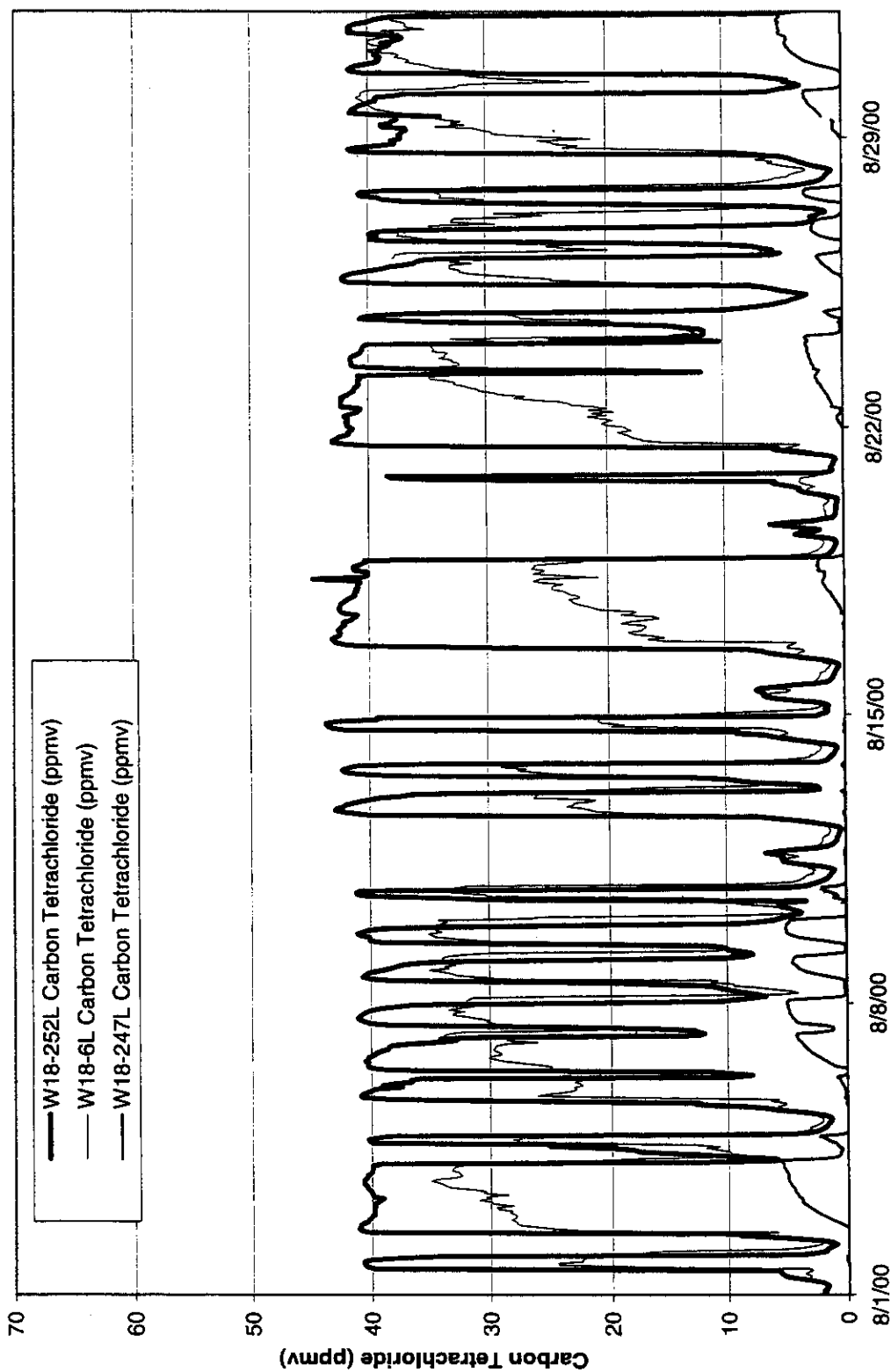


Figure C-22. Comparison of Carbon Tetrachloride Concentrations Monitored Hourly at Wells 299-W18-6L, 299-W18-247L, and 299-W18-252L, September 2000.

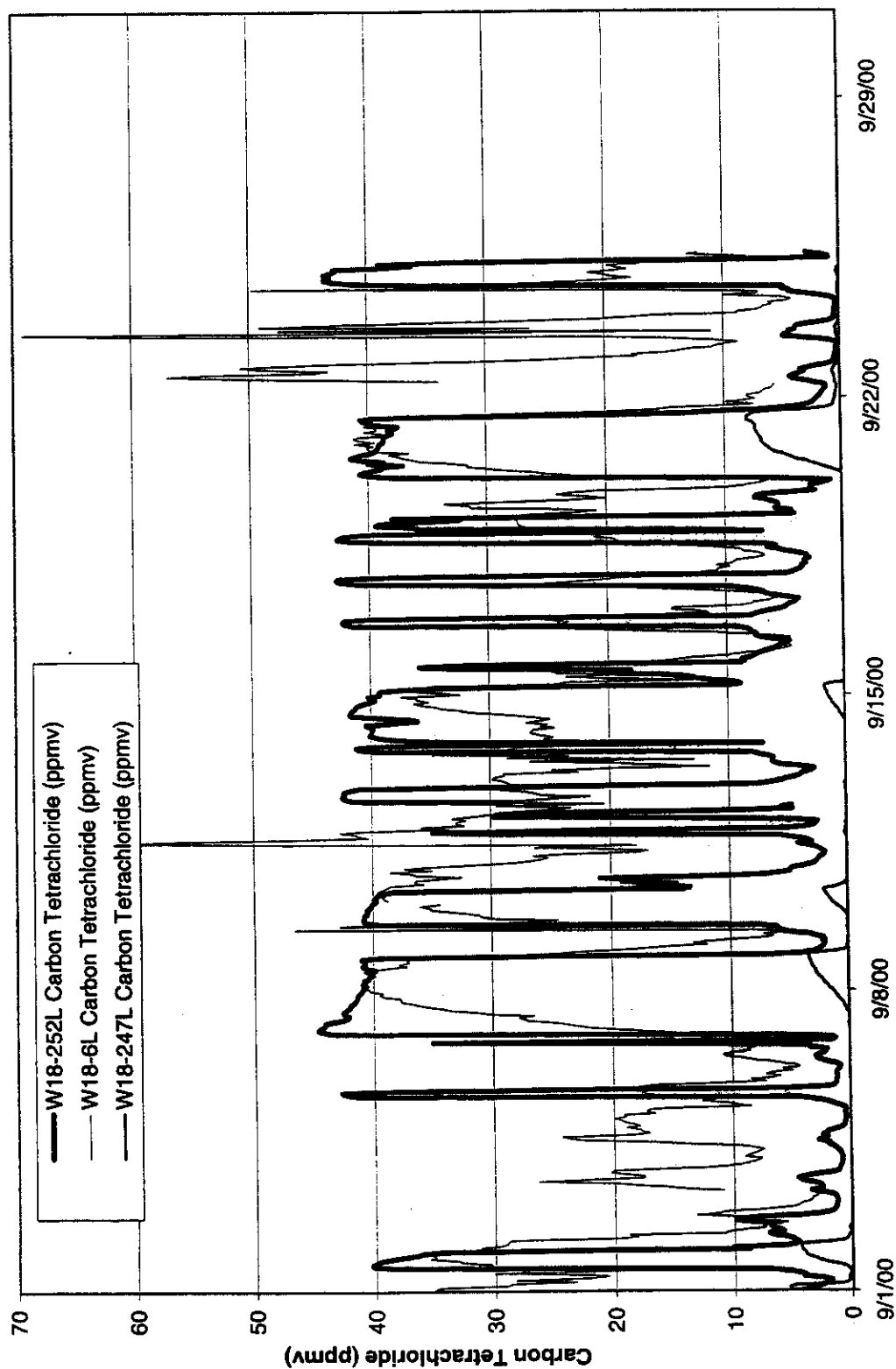


Table C-1. Sample Collection Data for GAC Cartridge Samples Collected fom PSVE Systems, October 1999.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	RCF HEIS Number	GAC Water Content	Comment
W18-6L	10/28/1999	9:45	10:20	B0WV21	B0WV41		
W18-7	10/26/1999	14:20	14:56	B0WV18	B0WV38	Dry	
W18-10L	10/26/1999	14:20	14:42	B0WV17	B0WV37	Moist	No organic vapor detectable by IH.
W18-11L	10/28/1999	12:15	12:25	B0WV23	B0WV43	Dry	
W18-12							Not yet set up with GAC filter.
W18-246L	10/28/1999	9:45	10:00	B0WV20	B0WV40	Wet	Water is present when filter is opened.
W18-247L	10/28/1999	8:20	8:50	B0WV19	B0WV39	Dry	
W18-252L	10/28/1999	11:05	11:30	B0WV22	B0WV42	Wet	
Clean GAC	10/28/1999		13:00	B0WV24	B0WV44	Dry	GAC contains flecks of oxidized iron from the drum.

Table C-2. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, October 1999.

Well No.	HEIS Number	Carbon Tetrachloride Removed 10/14/99-10/28/99 (g)	Solids (%)	Dry Weight ^a (kg)	Total Chloride ^b (mg/kg)	Sum of VOAs (mg/kg)	Carbon Tetrachloride (ug/kg)	Chloroform (ug/kg)	Methylene Chloride (ug/kg)	Trichloro-ethene (ug/kg)	Acetone (ug/kg)
W18-6L	B0WV21	2.91	71.1	0.45	8,260	5,003	4,600,000	83,000 J	320,000 B		
W18-7	B0WV18	1.05	76.8	0.45	1,630	2,031	1,800,000	55,000 J	160,000 B	16,000 J	
W18-10L	B0WV17	0.86	57.7	0.45	105	1,321	1,100,000	21,000 J	200,000 B		
W18-11L	B0WV23	0.87	82.6	0.45	1,430	1,725	1,600,000	15,000 J	110,000 B		
W18-12											
W18-246L	B0WV20	1.36	53.0	0.45	357	1,808	1,600,000	38,000 J	170,000 B		
W18-247L	B0WV19	0.75	89.7	0.45	1,510	1,667	1,500,000	15,000 J	100,000 B		52,000 JB
W18-252L	B0WV22	1.90	52.1	0.45	160	2,370	2,200,000		170,000 B		
Clean GAC	B0WV24	0.61	88.0	0.45	1,400	1,320	1,200,000		120,000 B		

^a Based on two loaded, "dry" GAC samples that weighed 0.45 kg on 1/27/00.^b Results are reported on a wet weight basis.

Note: W18-10L, W18-246L, W18-252L GAC samples wet when removed from well (Table C-1); corresponds to low Total Chloride value.

The method blanks contained the common laboratory contaminants methylene chloride and acetone at levels less than 2X the Contract-Required Quantitation Limit (CRQL) and the target compound 2-Butanone at levels less than the CRQL. (RECRA Analytical Report)

B = Indicates analyte is found in the associated blank as well as in the sample.

J = Indicates an estimated value.

Table C-3. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, November 1999

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	RCF HEIS Number ^a	GAC Water Content	Comment
W18-6L	11/29/1999	12:08	12:52	B0X464	B0WV41	Dry	No water in the lines when the filter was removed at well.
W18-7	11/29/1999	11:51	13:15	B0X467	B0WV38	Wet	No water in the lines when the filter was removed at well.
W18-10L	11/29/1999	11:57	12:56	B0X465	B0WV37	Wet	Some water in the lines when the filter was removed at well.
W18-11L	11/29/1999	12:16	12:37	B0X462	B0WV43	Dry	No water in the lines when the filter was removed at well.
W18-12	11/29/1999	12:02	13:26	B0X468	B0WV38	Wet	Some water in the lines when the filter was removed at well.
W18-246L	11/29/1999	12:12	12:42	B0X463	B0WV40	Wet	Some water in the lines when the filter was removed at well.
W18-247L	11/29/1999	12:19	12:30	B0X461	B0WV39	Dry	No water in the lines when the filter was removed at well.
W18-252L	11/29/1999	12:05	13:05	B0X466	B0WV42	Dry	Some water in the lines when the filter was removed at well.

^a The radscreens are from the previous sampling event (Table C-1), except for W18-12, at which a radscreen sample could not be collected during the last sampling event (W18-12 was not yet set up with a GAC cartridge in October 1999). Radscreen B0WV38, which has the highest readings, was assigned to W18-12.

On 11/29, samplers added clean GAC to seven cartridges to be placed on wells during the 11/29 changeout. The seven cartridges that were removed from these seven wells were sampled, refilled with clean GAC, and stored for the next changeout. The exception was W18-12. This cartridge was removed on 11/29, sampled, filled with clean GAC, and replaced back onto well W18-12 on 11/29.

Table C-4. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, November 1999.

Well No.	HEIS Number	Carbon Tetrachloride Removed 10/28/99-11/29/99 (g)	Solids ^a (%)	Dry Weight ^b (kg)	Carbon Tetrachloride (ug/kg)	Chloroform (ug/kg)	Methylene Chloride (ug/kg)	Trichloro-ethene (ug/kg)	Tetrachloro-ethene (ug/kg)	Acetone (ug/kg)	2-Butanone (ug/kg)	Chloro-methane (ug/kg)	Hexachloro-ethane (ug/kg)
W18-6L	B0X464	1.61	81	0.45	2,900,000 E	9,400	1,900 B	420 J	300 J	1,000 JB	250 JB	420 JB	
W18-7	B0X467	1.78	48	0.45	1,900,000 E	11,000	2,800 B	2,400	980 J	1,700 JB		560 JB	
W18-10L	B0X465	1.22	48	0.45	1,300,000 E	2,100	2,600 B			1,300 JB		530 JB	
W18-11L	B0X462	0.97	79	0.45	1,700,000 E	350,000	89,000 B			52,000 BJ	15,000 BJ	25,000 BJ	
W18-12	B0X468	3.00	51	0.45	3,400,000 E	5,800	2,800 B	510 J	430 J	2,200 JB	550 JB	440 JB	
W18-246L	B0X463	2.01	47	0.45	2,100,000 E	4,600	2,500 B	730 J	1,100 J	1,200 JB	300 JB	560 JB	
W18-247L	B0X461	0.66	82	0.45	1,200,000 E	6,900	2,200 B			1,200 JB	360 JB	410 JB	
W18-252L	B0X466	3.33	50	0.45	3,700,000 E	11,000	2,700 B	2,700	3,700	3,700 B	600 JB		2,000 NJ

^a From the Tentatively Identified Compounds (TIC) sheets "% Moisture: not dec."^b Based on two loaded, "dry" GAC samples that weighed 0.45 kg on 1/27/00.

The method blanks contained the common laboratory contaminants methylene chloride and acetone at levels less than 2X the Contract-Required Quantitation Limit (CRQL) and the target compound 2-Butanone at levels less than the CRQL. One method blank also contained the target compound chloromethane at a level less than the CRQL. (RECRA Analytical Report).

B = Indicates analyte is found in the associated blank as well as in the sample.

E = Indicates that the compound was detected beyond the calibration range and was subsequently analyzed at a dilution.

J = Indicates an estimated value.

N = Indicates presumptive evidence of a compound. The flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search.

Table C-5. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, December 1999.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	GAC Water Content	Comment
W18-6L	12/28/1999		12:55	B0XB97	Dry	
W18-7	12/28/1999	11:25	11:55	B0XB95	Dry	Well is venting. Drain approximately 10 oz. water from hoses.
W18-10L	12/28/1999	10:55	13:15	B0XB99	Very wet	Well is venting. Water inside cartridge when the cartridge was removed with approximately 1 oz. free liquid pouring out.
W18-11L	12/28/1999	10:50	13:20	B0XBB0	Dry	
W18-12	12/28/1999	11:35	11:40	B0XB94	Very moist	
W18-246L	12/28/1999	11:00	13:00	B0XB98	Very moist	Well slightly venting prior to cartridge changeout. Water and ice in cartridge when the cartridge was removed. Drain approximately 20 oz. water from hoses.
W18-247L	12/28/1999	10:45	13:25	B0XBB1	Dry	
W18-252L	12/28/1999	11:05	12:47	B0XB96	Dry	Well is venting. Drain approximately 6 oz. water from hoses.

On 12/28, samplers placed previously prepared and stored GAC cartridges on seven wells. The seven cartridges that were removed from these wells were sampled, refilled with clean GAC, and stored for the next changeout. The exception was W18-12. The cartridge was removed on 12/28, sampled, filled with clean GAC, and replaced back onto well W18-12 on 12/28.

Table C-6. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, December 1999.

Well No.	HEIS Number	Carbon Tetrachloride Removed 11/29/99-12/28/99 (g)	Solids (%)	Dry Weight ^a (kg)	Carbon Tetrachloride ^b (ug/kg)	Chloroform (ug/kg)	Methylene Chloride (ug/kg)	Trichloro-ethene (ug/kg)	Tetrachloro-ethene (ug/kg)	Acetone (ug/kg)	Chloro-methane (ug/kg)	Bromodi-chloro-methane (ug/kg)
W18-6L	B0XB97	0.70	64	0.45	1,000,000 BD	12,000	1,300 B	400 J	350 J	700 BJ	570 J	
W18-7	B0XB95	0.49	62	0.45	680,000 BD	24,000	1,100 BJ	7,800	2,800	410 BJ		470 J
W18-10L	B0XB99	0.13	52	0.45	150,000 D	1,900 J	3,300 B			1,700 BJ		
W18-11L	B0XBB0	0.25	77	0.45	430,000 BD	5,800	480 BJ			370 BJ	490 J	
W18-12	B0XB94	0.12	54	0.45	140,000 BD	2,000	520 BJ	400 J	320 J			
W18-246L	B0XB98	0.29	53	0.45	340,000 B		37,000 B			18,000 BJ		
W18-247L	B0XBB1	0.17	89	0.45	340,000 BD	4,400	1,000 B			450 BJ	430 J	
W18-252L	B0XB96	0.46	68	0.45	700,000 BD	7,200	820 BJ	530 J	440 J		350 J	

^a Based on two loaded, "dry" GAC samples that weighed 0.45 kg on 1/27/00.

^b Daily blank has carbon tetrachloride contamination at 1 ppb. Samples were not re-analyzed because carbon tetrachloride concentrations in samples are so much higher.

All method blanks contained the common laboratory contaminant methylene chloride and acetone at levels less than 2X the Contract-Required Quantitation Limit (CRQL). One method blank also contained the target compound carbon tetrachloride at a level less than the CRQL. (RECRA Analytical Report).

B = Indicates analyte is found in the associated blank as well as in the sample.

D = Identifies all compounds identified in an analysis at a secondary dilution factor.

J = Indicates an estimated value.

Table C-7. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, January 2000.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time.	TMA/RECRA HEIS Number	Weight of Used GAC Removed from Well (kg)	GAC Water Content	Comment
W18-6L	1/27/2000	12:00	13:15	B0XH10	0.50	Dry	Cartridge dry when cartridge removed.
W18-7	1/27/2000	12:15	13:05	B0XH09	0.64	Wet	
W18-10L	1/27/2000	11:35	14:00	B0XH14	1.03	Wet/frozen	Cartridge contained approx 10 oz water when cartridge removed.
W18-11L	1/27/2000	11:30	13:45	B0XH13	0.45	Dry	
W18-12	1/27/2000	11:40	13:25	B0XH11	0.95	Very wet	Cartridge contained approx 6-7 oz water when cartridge removed.
W18-246L	1/27/2000	11:50	12:47	B0XH08	0.73	Wet	Cartridge wet when cartridge removed.
W18-247L	1/27/2000	11:25	12:30	B0XH07	0.45	Dry	
W18-252L	1/27/2000	12:05	13:37	B0XH12	1.22	Wet (ice and visible water)	Cartridge wet when cartridge removed.

On 1/27, sampler placed previously prepared and stored GAC cartridges on all eight wells.

Table C-8. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, January 2000.

Well No.	HEIS Number	Carbon Tetrachloride Removed 12/28/99-1/27/00 (g)	Solids ^a (%)	Dry Weight ^b (kg)	Carbon Tetrachloride ^c (ug/kg)	Chloroform (ug/kg)	Methylene Chloride (ug/kg)	Trichloro-ethene (ug/kg)	Tetrachloro-ethene (ug/kg)	Acetone (ug/kg)	2-Butanone (ug/kg)	1,1,2-Trichloro-1,2-Ethane (ug/kg)	Silane (ug/kg)	Unknown (ug/kg)	Bromofluorobenzene (ug/kg)
W18-6L	B0XH10	1.96	71	0.45	3,100,000 D	24,000 J	28,000 B			30,000 BJ					9,000J
W18-7	B0XH09	0.76	53	0.45	900,000 D	26,000 J	11,000 BJ	15,000	7,600 J				90,000 JB	30,000 JB	
W18-10L	B0XH14	0.42	51	0.45	480,000	31,000 J									
W18-11L	B0XH13	0.70	64	0.45	1,000,000	20,000 J	32,000 B			32,000 BJ			200,000 JB		
W18-12	B0XH11	1.29	56	0.45	1,600,000 D	31,000	37,000 B			34,000 BJ			200,000 JB	40,000 JB	
W18-246L	B0XH08	0.45	53	0.45	530,000 D	11,000 J	12,000 BJ	2,400 J	2,300 J	23,000 BJ	11,000J	20,000 NJ	90,000 JB	20,000 JB	
W18-247L	B0XH07	1.24	58	0.45	1,600,000	51,000 J	29,000 BJ			45,000 BJ					
W18-252L	B0XH12	1.88	55	0.45	2,300,000 D	30,000 J	34,000 B						200,000 JB		

^a From the Tentatively Identified Compounds (TIC) sheets "% Moisture: not dec."^b Based on two loaded, "dry" GAC samples that weighed 0.45 kg on 1/27/00.^c Dilutions analyzed outside of holding time. All samples were extracted within required holding time. The extracts of these samples were analyzed within the holding time; however, dilutions and the associated matrix QC were analyzed outside of holding time (RECRA Analytical Report). It is expected that if the package were to be validated, the validator would apply a "J" qualifier for this type of missed holding time.

The method blanks contained the common laboratory contaminant methylene chloride at levels less than 2X the Contract-Required Quantitation Limit (CRQL). Two method blanks also contained the target compounds 2-Hexanone and 1,1,2,2-Tetrachloroethane at levels less than the CRQL. One method blank also contained the target compounds chloromethane, bromomethane, and bromoform at levels less than the CRQL (RECRA Analytical Report).

B = Identifies analysis is found in the associated blank as well as in the sample.

D = Identifies all compounds identified in an analysis at a secondary dilution factor.

J = Indicates an estimated value.

N = Indicates presumptive evidence of a compound. The flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search.

Table C-9. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, February 2000.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	Weight of Used GAC Removed from Well (kg)	GAC Water Content	Weight of Clean GAC Stored for Next Changeout ^a (kg)	Comments
W18-6L	2/29/2000	9:13	10:15	B0XP47	0.91	Dry	0.591	No visible water when cartridge removed.
W18-7	2/29/2000	9:24	11:06	B0XP51	1.13	Wet	0.662	20 mL of water ran out when cartridge removed.
W18-10L	2/29/2000	8:57	9:42	B0XP44	1.22	Wet	0.625	Approximately 1 L of water present when cartridge removed.
W18-11L	2/29/2000	8:47	9:54	B0XP45	0.68	Dry	0.585	No visible water when cartridge removed.
W18-12	2/29/2000	9:03	10:04	B0XP46	1.81	Wet	0.613	60 mL of water ran out when cartridge removed.
W18-246L	2/29/2000	9:09	10:27	B0XP48	1.36	Wet	0.694	No visible water when cartridge removed.
W18-247L	2/29/2000	8:40	10:38	B0XP49	0.91	Dry	0.645	No visible water when cartridge removed.
W18-252L	2/29/2000	9:18	10:57	B0XP50	1.32	Wet	0.633	No visible water when cartridge removed.

^a Weighed on 6/1/00.

Table C-10. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, February 2000.

Well No.	HEIS Number	Carbon Tetrachloride Removed 1/27/00-2/29/00 (g)	Solids (%)	Dry Weight ^a (kg)	Carbon Tetrachloride (ug/kg)	Chloroform (ug/kg)	Methylene Chloride (ug/kg)	Trichloro-ethene (ug/kg)	Acetone (ug/kg)	Chloro-methane (ug/kg)	1,1,2,2-Tetra chloroethane (ug/kg)
W18-6L	BOXP47	0.97	55.8	0.45	1,200,000 E	13,000 J	42,000 B				
W18-7	BOXP51	1.74	54.4	0.45	2,100,000	37,000 J	94,000 B			44,000 J	
W18-10L	BOXP44	0.55	71.4	0.45	870,000		28,000 BJ		92,000 BJ	10,000 J	
W18-11L	BOXP45	0.41	55.5	0.45	500,000	12,000 J	39,000 B				
W18-12	BOXP46	0.22	75.8	0.45	370,000	9,700 J	33,000 B				
W18-246L	BOXP48	0.74	54.1	0.45	890,000	18,000 J	34,000 BJ	11,000 J	100,000 BJ		
W18-247L	BOXP49	0.38	54.2	0.45	460,000	8,800 J	40,000 B		82,000		8,100 J
W18-252L	BOXP50	0.51	77.3	0.45	870,000	11,000 J	33,000 B				

^a Based on two loaded, "dry" GAC samples that weighed 0.45 kg on 1/27/00.

The method blanks contained the common laboratory contaminants methylene chloride and/or acetone at levels less than the Contract-Required Quantitation Limit (CRQL). (RECRA Analytical Report)

B = Indicates analyte is found in the associated blank as well as in the sample.

E = Indicates that the compound was detected beyond the calibration range and was subsequently analyzed at a dilution.

J = Indicates an estimated value.

Table C-11. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, May 2000.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	Weight of Used GAC Removed from Well (kg)	GAC Water Content	Weight of Clean GAC Stored for Next Changeout (kg)	Comment
W18-6L	6/1/2000	8:56	9:07	B0XV76	0.795	Dry	0.650	No visible water when cartridge removed.
W18-7	6/1/2000	8:40	9:15	B0XV83	0.783	Dry	0.651	No visible water when cartridge removed.
W18-10L	6/1/2000	8:44	9:22	B0XV81	0.765	Dry	0.650	No visible water when cartridge removed.
W180-11L	6/1/2000	8:47	9:28	B0XV77	0.621	Dry	0.617	No visible water when cartridge removed.
W18-12	6/1/2000	8:50	9:35	B0XV79	0.676	Dry	0.590	No visible water when cartridge removed.
W18-246L	6/1/2000	9:00	9:43	B0XV82	0.715	Dry	0.518	No visible water when cartridge removed.
W18-247L	6/1/2000	9:04	9:50	B0XV78	0.668	Dry	0.600	No visible water when cartridge removed.
W18-252L	6/1/2000	8:54	9:58	B0XV84	0.685	Dry	0.577	No visible water when cartridge removed.
Clean GAC	6/1/2000		10:04	B0XV80				Sample collected from the clean GAC material that was placed in each filter.

Table C-12. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, May 2000.

Well No.	HEIS Number	Carbon Tetrachloride Removed 2/29/00- 6/1/00 (g)	Solids (%)	Dry Weight ^a (kg)	Carbon Tetrachloride (ug/kg)	Chloroform (ug/kg)	Methylene Chloride (ug/kg)	Unknown (ug/kg)
W18-6L	B0XV76	2.10	77.3	0.45	3,600,000		400,000 NJ	
W18-7	B0XV83	3.07	80.6	0.45	5,500,000	200,000 NJ	400,000 NJ	
W18-10L	B0XV81	0.93	96.8	0.45	2,000,000	100,000 NJ	80,00 NJ	
W18-11L	B0XV77	0.86	89.0	0.45	1,700,000		90,00 NJ	
W18-12	B0XV79	2.34	84.5	0.45	4,400,000	300,000 NJ	300,00 NJ	
W18-246L	B0XV82	7.29	80.2	0.45	13,000,000		2,000,00 NJ	
W18-247L	B0XV78	1.02	83.5	0.45	1,900,000		80,000 NJ	100,000 J
W18-252L	B0XV84	2.51	80.8	0.45	4,500,000		400,000 NJ	
clean GAC	B0XV80	0.06	79.7	0.45	110,000		10,000 NJ	

^a Based on two loaded, "dry" GAC samples that weighed 0.45 kg on 1/27/00.

J = Indicates an estimated value.

N = Indicates presumptive evidence of a compound. The flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search.

Table C-13. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, June 2000.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	Weight of Used GAC Removed from Well (kg)	GAC Water Content	Weight of Clean GAC Stored for Next Changeout (kg)	Comment
W18-6L	6/27/2000	8:15	8:50	B0YM42	0.636	Dry	0.625	Sampled GAC material was dry.
W18-7	6/27/2000	8:15	9:05	B0YM43	0.647	Dry	0.585	Sampled GAC material was dry.
W18-10L	6/27/2000	8:15	9:15	B0YM44	0.593	Dry	0.623	Sampled GAC material was dry.
W18-11L	6/27/2000	8:15	9:30	B0YM45	0.605	Dry	0.590	Sampled GAC material was dry.
W18-12	6/27/2000	8:15	9:45	B0YM46	0.585	Dry	0.630	Sampled GAC material was dry.
W18-246L	6/27/2000	8:15	9:50	B0YM47	0.679	Dry	0.618	Sampled GAC material was dry.
W18-247L	6/27/2000	8:15	10:00	B0YM48	0.607	Dry	0.570	Sampled GAC material was dry.
W18-252L	6/27/2000	8:15	10:15	B0YM49	0.610	Dry	0.618	Sampled GAC material was dry.

Table C-14. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, June 2000.

Well No.	HEIS Number	Carbon Tetrachloride Removed 6/1/00-6/27/00 (g)	Solids (%)	Dry Weight (kg)	Carbon Tetrachloride (ug/kg)
W18-6L	B0YM42	1.37	86.0	0.591	2,000,000
W18-7	B0YM43	15.22	87.0	0.662	20,000,000
W18-10L	B0YM44	2.51	92.0	0.625	3,700,000
W18-11L	B0YM45	0.35	88.0	0.585	530,000
W18-12	B0YM46	16.86	90.9	0.613	25,000,000
W18-246L	B0YM47	24.17	80.4	0.694	28,000,000
W18-247L	B0YM48	2.03	85.8	0.645	2,700,000
W18-252L	B0YM49	8.79	93.6	0.633	13,000,000

Table C-15. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, July 2000.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	Weight of Used GAC Removed from Well (kg)	GAC Water Content	Weight of Clean GAC Stored for Next Changeout (kg)	Comment
W18-6L	7/31/2000	6:15	6:55	B0YW25	0.637	Dry	0.723	
W18-7	7/31/2000	6:15	7:10	B0YW26	0.695	Dry	0.585	
W18-10L	7/31/2000	6:15	7:20	B0YW27	0.634	Dry	0.709	
W18-11L	7/31/2000	6:15	7:30	B0YW28	0.596	Dry	0.663	
W18-12	7/31/2000	6:15	7:40	B0YW29	0.664	Dry	0.550	
W18-246L	7/31/2000	6:15	7:48	B0YW30	0.660	Dry	0.574	
W18-247L	7/31/2000	6:15	7:55	B0YW31	0.596	Dry	0.600	
W18-252L	7/31/2000	6:15	8:05	B0YW32	0.615	Dry	0.584	

Table C-16. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, July 2000.

Well No.	HEIS Number	Carbon Tetrachloride Removed 6/27/00-7/31/00 (g)	Solids (%)	Dry Weight (kg)	Carbon Tetrachloride (ug/kg)	1,1-Difluoroethane (ug/kg)	Unknown (ug/kg)
W18-6L	B0YW25	2.33	94.8	0.650	3,400,000		
W18-7	B0YW26	37.53	90.2	0.651	52,000,000		
W18-10L	B0YW27	2.68	94.5	0.650	3,900,000	10 JN	
W18-11L	B0YW28	1.50	98.5	0.617	2,400,000	10 JN	5 J
W18-12	B0YW29	17.19	85.8	0.590	25,000,000		
W18-246L	B0YW30	15.51	90.2	0.518	27,000,000		
W18-247L	B0YW31	1.05	97.2	0.600	1,700,000		
W18-252L	B0YW32	4.22	95.8	0.577	7,000,000		

J = Indicates an estimated value.

N = Indicates presumptive evidence of a compound. The flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search.

Table C-17. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, August 2000.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	Weight of Used GAC Removed from Well (kg)	GAC Water Content	Weight of Clean GAC Stored for Next Changeout (kg)	Comment
W18-6L	8/29/2000	7:40	8:25	B104N3	0.671	Dry	0.569	
W18-7	8/29/2000	7:40	8:39	B104N4	0.624	Dry	0.568	
W18-10L	8/29/2000	7:40	8:50	B104N5	0.619	Dry	0.642	
W18-11L	8/29/2000	7:40	9:00	B104N6	0.575	Dry	0.555	
W18-12	8/29/2000	7:40	9:13	B104N7	0.637	Dry	0.545	
W18-246L	8/29/2000	7:40	9:30	B104N8	0.575	Dry	0.620	
W18-247L	8/29/2000	7:40	9:39	B104N9	0.556	Dry	0.545	
W18-252L	8/29/2000	7:40	9:50	B104P0	0.650	Dry	0.590	

Table C-18. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, August 2000.

Well No.	HEIS Number	Carbon Tetrachloride Removed 7/31/00-8/29/00 (g)	Solids (%)	Dry Weight (kg)	Carbon Tetrachloride (ug/kg)	Methylene Chloride (ug/kg)
W18-6L	B104N3	2.63	88.0	0.625	3,700,000	3,000,000 NJ
W18-7	B104N4	2.01	93.3	0.585	3,200,000	3,000,000 NJ
W18-10L	B104N5	1.25	94.8	0.623	1,900,000	200,000 NJ
W18-11L	B104N6	0.19	93.4	0.590	300,000	40,000 NJ
W18-12	B104N7	3.72	93.2	0.630	5,500,000	2,000,000 NJ
W18-246L	B104N8	6.99	97.3	0.618	11,000,000	2,000,000 NJ
W18-247L	B104N9	0.16	97.2	0.570	280,000	40,000 NJ
W18-252L	B104P0	4.57	92.0	0.618	6,800,000	2,000,000 NJ

J = Indicates an estimated value.

N = Indicates presumptive evidence of a compound. The flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search.

Table C-19. Sample Collection Data for GAC Cartridge Samples Collected from PSVE Systems, September 2000.

Well No.	GAC Collection Date	GAC Collection Time	GAC Sample Time	TMA/RECRA HEIS Number	Weight of Used GAC Removed from Well (kg)	GAC Water Content	Weight of Clean GAC Stored for Next Changeout (kg)	Comment
W18-6L	9/27/2000	10:14	11:35	B10F00	0.873	Dry	0.589	
W18-7	9/27/2000	10:14	12:56	B10F06	0.914	Wet	0.528	
W18-10L	9/27/2000	10:14	12:45	B10F05	0.875	Dry	0.500	
W18-11L	9/27/2000	10:14	12:25	B10F03	0.603	Dry	0.517	
W18-12	9/27/2000	10:14	12:10	B10F02	0.641	Dry	0.486	
W18-246L	9/27/2000	10:14	11:11	B10DY9	0.570	Dry	0.521	
W18-247L	9/27/2000	10:14	12:36	B10F04	0.662	Dry	0.530	
W18-252L	9/27/2000	10:14	11:55	B10F01	0.633	Dry	0.541	

Table C-20. Analytical Data for GAC Cartridge Samples Collected from PSVE Systems, September 2000.

Well No.	HEIS Number	Carbon Tetrachloride Removed 8/29/00-9/27/00 (g)	Solids (%)	Dry Weight (kg)	Carbon Tetrachloride (ug/kg)
W18-6L	B10F00	3.53	79.9	0.723	3,900,000
W18-7	B10F06	0.97	60.4	0.585	1,000,000
W18-10L	B10F05	1.58	76.2	0.709	1,700,000
W18-11L	B10F03	0.07	99.5	0.663	100,000
W18-12	B10F02	6.05	89.1	0.550	9,800,000
W18-246L	B10DY9	0.44	97.9	0.574	750,000
W18-247L	B10F04	0.34	88.7	0.600	510,000
W18-252L	B10F01	2.63	88.8	0.584	4,000,000

**Table C-21. Volume of Water Drained from GAC Cartridges and Hoses
During Sample Collection at the PSVE Systems.**

Well No.	12/28/99 Volume from Hoses (L)	12/28/1999 Volume from GAC (L)	1/13/2000 Volume from Hoses (L)	1/27/2000 Volume from GAC (L)	2/29/2000 Volume from GAC (L)	3/23/00 Volume from Hoses (L)
W18-6L			3.79			1.89
W18-7	0.30		0.47		0.02	0.95
W18-10L		0.03	1.89	0.30	1.00	0.12
W18-11L			dry			dry
W18-12			0.47	0.19	0.06	0.47
W18-246L	0.59		0.95			0.24
W18-247L			0.95			0.95
W18-252L	0.18		0.95			0.95
Total	1.06	0.03	9.46	0.49	1.08	5.56

Table C-22. Passive Soil Vapor Extraction Well Network. (3 Pages)

Well/Probe	Purpose	Instrumentation			Comment	Open Interval (m bgs)
		Datalogger	Parameter	Instrument		
299-W18-6L	Passive extraction	Datalogger	Differential Pressure	Ashcroft +/- 2.5 kPa (10 in. w.c.)	Two 60-m lengths of sample tubing dropped in well	57.9 – 61.3 (190 – 201 ft)
			Airflow	Sierra 0 to 76 m/min (0 to 250 ft/min)		
			Temperatures at 3 m, 61 m (10 ft, 200 ft) below top of well	Type K thermocouple wire		
			CCl ₄	B&K		
			CCl ₄	GAC		
			Valve	Baroball		
299-W18-6U	Monitoring	Datalogger	Differential Pressure	Ashcroft +/- 6.2 kPa (25 in. w.c.)	Sealed well	28.8 – 37.9 (94.5 – 124.5 ft)
299-W18-7	Passive extraction	None	CCl ₄	GAC		51.4 – 61.9 (168.5 – 203 ft)
			Valve	Baroball		

Table C-22. Passive Soil Vapor Extraction Well Network. (3 Pages)

Well/Probe	Purpose	Instrumentation			Comment	Open Interval (m bgs)
		Datalogger	Parameter	Instrument		
299-W18-9	Monitoring	Datalogger	Differential pressure Temperatures at 3 m, 61 m (10 ft, 200 ft) below top of well	Ashcroft +/- 2.5 kPa (10 in. w.c.) Type K thermocouple wire	Sealed well	54.9 - 64.5 (180 - 211.5 ft)
299-W18-10L	Passive extraction	None	CCl4 Valve	GAC Baroball		44.8 - 64.3 (147 - 211 ft)
299-W18-11L	Passive extraction	None	CCl4 Valve	GAC Baroball		54.9 - 64.9 (180 - 213 ft)
299-W18-12	Passive extraction	None	CCl4 Valve	GAC Baroball		54.1 - 64.9 (177.5 - 213 ft)
299-W18-246L	Passive extraction	None	CCl4 Valve	GAC INEL valve		50.3 - 53.3 (165 - 175 ft)
299-W18-247L	Passive extraction	Datalogger	Differential pressure Airflow Temperatures at 3 m, 61 m (10 ft, 200 ft) below top of well CCl4 CCl4 Valve	Ashcroft +/- 2.5 kPa (10 in. w.c.) Sierra 0 to 76 m/min (0 to 250 ft/min) Type K thermocouple wire B&K GAC Baroball	Well with long passive extraction record	49.4 - 52.4 (162 - 172 ft)

Table C-22. Passive Soil Vapor Extraction Well Network. (3 Pages)

Well/Probe	Purpose	Instrumentation			Comment	Open Interval (m bgs)
		Datalogger	Parameter	Instrument		
299-W18-247U	Monitoring	Datalogger	Differential pressure	Ashcroft +/- 6.2 kPa (25 in. w.c.)	Sealed well	36.3 – 39.3 (119 – 129 ft)
299-W18-252L	Passive extraction	Datalogger	Differential pressure	Ashcroft +/- 2.5 kPa (10 in. w.c.)		50.3 – 56.4 (165 – 185 ft)
			Airflow	Sierra 0 to 76 m/min (0 to 250 ft/min)		
			Temperatures at 3 m, 61 m (10 ft, 200 ft) below top of well	Type K thermocouple wire		
			Barometric pressure	Setra		
			CCl4	B&K		
			CCl4	GAC		
			Valve	Baroball		
299-W18-252U	Monitoring	Datalogger	Differential pressure	Ashcroft +/- 2.5 kPa (10 in. w.c.)	Sealed well	34.4 – 40.5 (113 – 133 ft)
299-W18-252/SST100 (red)	Monitoring	Datalogger	Differential pressure	Ashcroft +/- 1.2 kPa (5 in. w.c.)	Stainless steel tubes strapped to outside of casing; color refers to banding on individual tubes	30.5 (100 ft)
299-W18-252/SST145 (blue)	Monitoring	Datalogger	Differential pressure	Ashcroft +/- 2.5 kPa (10 in. w.c.)		44.2 (145 ft)
299-W18-252/SST210 (yellow)	Monitoring	Datalogger	Differential pressure	Ashcroft +/- 2.5 kPa (10 in. w.c.)		64.0 (210 ft)
CPT-4F/10 (black)	Monitoring	Datalogger	Differential pressure	JYC – 0.25 to + 0.25 kPa (-1 to +1 in. w.c.)	Soil probes emplaced using cone penetrometer; color refers to banding on the individual tubes	3 (10 ft)
CPT-4F/25 (white)	Monitoring	Datalogger	Differential pressure	JYC – 0.25 to + 0.25 kPa (-1 to +1 in. w.c.)		7.6 (25 ft)
CPT-4F/50 (blue)	Monitoring	Datalogger	Differential pressure	JYC – 0.25 to + 0.25 kPa (-1 to +1 in. w.c.)		15.2 (50 ft)
CPT-4F/75 (yellow)	Monitoring	Datalogger	Differential pressure	Ashcroft +/- 6.2 kPa (25 in. w.c.)		22.9 (75 ft)
CPT-4F/109 (red)	Monitoring	Datalogger	Differential pressure	Ashcroft +/- 1.2 kPa (5 in. w.c.)		33.2 (109 ft)

**Table C-23. Concentrations of Contaminants Measured During Passive Soil Vapor Extraction,
October 1999 - September 2000.**

Well	Carbon Tetrachloride Concentration (ppmv)		Chloroform Concentration (ppmv)		Methylene Chloride Concentration (ppmv)		Methyl Ethyl Ketone Concentration (ppmv)		Water Concentration (ppmv)		
	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Minimum	Average
W18-6L	69.2	19.2	6.4	0.7	50.0	6.2	10.3	1.4	70,100.0	3,500.0	15,924.4
W18-247L	8.1	1.0	10.2	2.0	21.3	4.0	5.7	0.9	38,500.0	3,280.0	13,102.4
W18-252L	44.7	17.6	9.3	0.2	20.2	2.2	10.3	0.4	48,400.0	3,340.0	13,761.3

Table C-24. Temperatures, Pressures, and Flowrates Measured During Passive Soil Vapor Extraction, October 1999 - September 2000.

Well/Probe	Temperature Maximum (oC)	Temperature Minimum (oC)	Differential Pressure Maximum Positive (kPa)	Differential Pressure Minimum Negative (kPa)	Differential Pressure Average Positive (kPa)	Differential Pressure Average Negative (kPa)	Flowrate Maximum (m ³ /min)	Flowrate Average of All Recorded Flows (m ³ /min)	Flowrate Average of Flows Above Threshold ^a (m ³ /min)
W18-6L	20.4	19.3	1.30	-1.41	0.30	-0.32	0.27	0.02	0.11
W18-6U	23.6	4.3	0.72	-0.56	0.11	-0.11			
W18-247L	20.4	18.9	1.35	-1.48	0.32	-0.33	0.19	0.01	0.11
W18-247U	29.3	2.5	1.19	-2.44	0.32	-0.77			
W18-252L	20.2	19.6	0.98	-1.03	0.19	-0.20	0.29	0.03	0.11
W18-252U	25.9	4.2	0.78	-0.60	0.14	-0.12			
W18-9 bottom	19.8	17.9	0.68	-0.59	0.09	-0.11			
W18-9 top	25.4	7.9							
W18-252SST100			0.77	-0.58	0.13	-0.12			
W18-252SST145			1.29	-1.40	0.34	-0.31			
W18-252SST210			1.28	-1.39	0.33	-0.31			
CPT-4F/ 10			0.03	-0.05	0.00	-0.01			
CPT-4F/ 25			0.08	-0.04	0.01	-0.01			
CPT-4F/ 50			0.16	-0.10	0.03	-0.02			
CPT-4F/ 75			0.24	-0.58	0.06	-0.24			
CPT-4F/ 109			0.68	-0.58	0.11	-0.12			

^a Threshold flows are as follows: W18-6L = 0.03 m³/min; W18-247L = 0.05 m³/min; W18-252L = 0.04 m³/min.

APPENDIX D

FISCAL YEAR 1998 SOIL VAPOR MONITORING DATA

Table D-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (6 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
79-01/ 5 ft	2	1	8/14/98 0:00	--	--	--	--	--	--	Destroyed or not found
79-03/ 5 ft	2	1	9/29/98 8:00	0.000	0.0	0.0	0.0	0.0	11,000	Substituted for 79-01
79-11/ 5 ft	2	1	12/1/97 13:55	-0.010	0.0	0.0	0.0	0.0	8,280	
79-11/ 5 ft	2	1	1/10/98 12:08	-0.010	0.0	0.0	0.0	0.0	4,860	
79-11/ 5 ft	2	1	1/29/98 10:16	-0.007	0.0	0.0	0.0	0.0	8,170	
79-11/ 5 ft	2	1	2/26/98 11:44	-0.002	0.0	0.0	0.0	0.0	7,120	
79-11/ 5 ft	2	1	3/24/98 8:06	-0.002	0.0	0.0	0.0	0.0	9,050	
79-11/ 5 ft	2	1	8/14/98 10:47	0.017	0.0	0.0	0.0	0.0	9,830	Analyzed on 8/15/98
79-11/ 5 ft	2	1	9/29/98 10:53	0.005	0.0	0.0	0.0	0.0	16,600	
87-01R/ 5 ft	2	1	12/1/97 13:18	-0.007	0.0	0.0	0.0	0.0	8,430	
87-01R/ 5 ft	2	1	1/10/98 14:40	-0.012	0.0	0.0	0.0	0.0	5,050	
87-01R/ 5 ft	2	1	1/29/98 11:46	-0.005	0.0	0.0	0.0	0.0	8,380	
87-01R/ 5 ft	2	1	2/26/98 13:01	-0.032	0.0	5.0	1.4	0.0	6,940	
87-01R/ 5 ft	2	1	3/24/98 10:23	0.000	0.0	0.0	0.0	0.0	9,540	
87-01R/ 5 ft	2	1	8/14/98 7:34	0.002	0.0	1.1	0.0	0.0	9,780	Partially destroyed, analyzed on 8/15/98
87-03/ 5 ft	2	1	9/29/98 10:03	0.002	0.0	0.0	0.0	0.0	13,300	Substituted for 87-01R
87-05/ 5 ft	2	1	8/14/98 10:04	0.010	0.0	1.0	0.0	0.0	9,750	Analyzed on 8/15/98
87-05/ 5 ft	2	1	9/29/98 10:09	0.002	0.0	0.0	0.0	0.0	12,700	
87-09/ 5 ft	2	1	12/1/97 13:44	-0.085	0.0	0.0	0.0	0.0	8,120	
87-09/ 5 ft	2	1	1/10/98 12:00	-0.010	0.0	0.0	0.0	0.0	4,700	
87-09/ 5 ft	2	1	1/29/98 10:00	-0.010	0.0	0.0	0.0	0.0	7,840	
87-09/ 5 ft	2	1	2/26/98 11:17	-0.007	0.0	0.0	0.0	0.0	6,360	

Table D-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (6 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
87-09/ 5 ft	2	1	3/24/98 7:53	-0.002	0.0	0.0	0.0	0.0	8,970	
87-09/ 5 ft	2	1	8/14/98 11:27	0.017	0.0	0.0	0.0	0.0	9,770	Analyzed on 8/15/98
87-09/ 5 ft	2	1	9/29/98 11:17	0.007	1.5	0.0	0.0	0.0	18,800	
N-6/ 5 ft	2	1	12/1/97 14:20	-0.102	0.0	0.0	0.0	0.0	8,520	
N-6/ 5 ft	2	1	1/10/98 0:00	--	--	--	--	--	--	Sample tube clogged
N-6/ 5 ft	2	1	1/29/98 0:00	--	--	--	--	--	--	Unable to sample
N-6/ 5 ft	2	1	2/5/98 8:15	--	--	--	--	--	--	Sample tube clogged
N-6/ 5 ft	2	1	2/26/98 0:00	--	--	--	--	--	--	Could not pull a sample
N-6/ 5 ft	2	1	3/24/98 12:25	0.017	0.0	0.0	1.1	0.0	13,800	
CPT-13A/ 9 ft	3	2	12/1/97 14:00	-0.007	0.0	0.0	0.0	0.0	8,270	
CPT-13A/ 9 ft	3	2	1/10/98 12:15	-0.010	0.0	0.0	0.0	0.0	4,940	
CPT-13A/ 9 ft	3	2	1/29/98 10:23	-0.012	0.0	0.0	0.0	0.0	8,260	
CPT-13A/ 9 ft	3	2	2/26/98 11:36	-0.002	0.0	0.0	0.0	0.0	7,000	
CPT-13A/ 9 ft	3	2	3/24/98 12:15	0.007	0.0	0.0	1.4	0.0	11,100	
CPT-13A/ 9 ft	3	2	4/30/98 7:41	-0.010	0.0	0.0	1.1	0.0	8,980	
CPT-13A/ 9 ft	3	2	5/26/98 6:47	0.005	0.0	0.0	0.0	0.0	8,070	
CPT-13A/ 9 ft	3	2	6/29/98 7:16	-0.007	0.0	3.3	0.0	0.0	13,500	
CPT-13A/ 9 ft	3	2	8/14/98 10:55	0.017	0.0	0.0	0.0	0.0	9,810	Analyzed on 8/15/98
CPT-13A/ 9 ft	3	2	9/29/98 10:59	0.007	0.0	0.0	0.0	0.0	17,100	
CPT-31/ 25 ft	8	2	12/1/97 14:54	-0.022	0.0	0.0	0.0	0.0	7,900	
CPT-31/ 25 ft	8	2	1/10/98 14:20	-0.100	0.0	0.0	0.0	0.0	4,980	
CPT-31/ 25 ft	8	2	1/29/98 11:22	0.000	0.0	0.0	0.0	0.0	8,760	
CPT-31/ 25 ft	8	2	2/26/98 12:51	-0.007	0.0	0.0	0.0	0.0	7,030	
CPT-31/ 25 ft	8	2	3/24/98 10:00	-0.002	0.0	0.0	0.0	0.0	9,480	

Table D-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (6 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
CPT-31/ 25 ft	8	2	8/14/98 8:51	0.007	0.0	0.0	0.0	0.0	9800	Analyzed on 8/15/98
CPT-31/ 25 ft	8	2	9/29/98 9:23	-0.010	0.0	0.0	0.0	0.0	12,300	
CPT-32/ 25 ft	8	2	12/1/97 14:26	-0.007	0.0	0.0	0.0	0.0	8,220	
CPT-32/ 25 ft	8	2	1/10/98 14:30	-0.010	0.0	0.0	0.0	0.0	5,430	
CPT-32/ 25 ft	8	2	1/29/98 11:15	-0.010	5.1	0.0	0.0	0.0	8,640	
CPT-32/ 25 ft	8	2	2/26/98 12:44	-0.007	6.6	0.0	0.0	0.0	6,950	
CPT-32/ 25 ft	8	2	3/24/98 10:06	-0.010	9.1	0.0	0.0	1.1	9,630	
CPT-32/ 25 ft	8	2	8/14/98 10:16	0.012	0.0	1.2	1.2	0.0	9850	Analyzed on 8/15/98
CPT-32/ 25 ft	8	2	9/29/98 10:14	0.000	0.0	0.0	0.0	0.0	15,000	
CPT-7A/ 32 ft	10	2	12/1/97 14:42	-0.010	0.0	0.0	0.0	0.0	8,050	
CPT-7A/ 32 ft	10	2	1/10/98 14:50	-0.010	0.0	0.0	0.0	0.0	5,590	
CPT-7A/ 32 ft	10	2	1/29/98 9:53	-0.012	1.9	0.0	0.0	0.0	7,830	
CPT-7A/ 32 ft	10	2	2/26/98 11:02	-0.002	2.3	0.0	0.0	0.0	6,390	
CPT-7A/ 32 ft	10	2	3/24/98 7:46	-0.007	2.2	0.0	0.0	0.0	9,070	
CPT-7A/ 32 ft	10	2	8/14/98 11:46	0.032	1.4	1.0	0.0	0.0	9,720	Analyzed on 8/15/98
CPT-7A/ 32 ft	10	2	9/29/98 11:22	-0.005	1.7	0.0	0.0	0.0	17,000	
CPT-1A/ 35 ft	11	2	12/1/97 15:13	-0.012	0.0	0.0	0.0	0.0	8,190	
CPT-1A/ 35 ft	11	2	1/10/98 14:35	-0.012	0.0	0.0	0.0	0.0	5,500	
CPT-1A/ 35 ft	11	2	1/29/98 11:40	0.000	0.0	0.0	0.0	0.0	8,010	
CPT-1A/ 35 ft	11	2	2/26/98 13:08	-0.002	0.0	0.0	0.0	0.0	6,530	
CPT-1A/ 35 ft	11	2	3/24/98 10:18	0.000	1.2	0.0	0.0	0.0	9,220	
CPT-1A/ 35 ft	11	2	4/30/98 7:35	-0.017	1.2	0.0	0.0	0.0	8,760	
CPT-1A/ 35 ft	11	2	5/26/98 6:40	0.002	1.3	0.0	0.0	0.0	7,970	
CPT-1A/ 35 ft	11	2	6/29/98 7:10	-0.020	0.0	3.5	0.0	0.0	13,100	

Table D-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (6 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
CPT-1A/ 35 ft	11	2	8/14/98 7:55	0.005	1.4	0.0	0.0	0.0	9,750	Analyzed on 8/15/98
CPT-1A/ 35 ft	11	2	9/29/98 7:53	-0.012	1.1	0.0	0.0	0.0	10,700	
CPT-33/ 40 ft	12	2	12/1/97 15:00	-0.017	0.0	0.0	0.0	0.0	7,960	
CPT-33/ 40 ft	12	2	1/10/98 14:04	-0.017	1.8	0.0	0.0	0.0	5,390	
CPT-33/ 40 ft	12	2	1/29/98 11:32	-0.007	1.8	0.0	0.0	0.0	8,230	
CPT-33/ 40 ft	12	2	2/26/98 12:57	-0.002	1.3	0.0	0.0	0.0	6,870	
CPT-33/ 40 ft	12	2	3/24/98 9:35	0.002	1.4	0.0	0.0	0.0	9,320	
CPT-33/ 40 ft	12	2	8/14/98 8:40	0.007	1.1	0.0	0.0	0.0	9,810	Analyzed on 8/15/98
CPT-33/ 40 ft	12	2	9/29/98 9:15	-0.012	2.0	0.0	0.0	0.0	12,100	
CPT-34/ 86 ft	26	2	8/14/98 8:12	0.000	4.5	2.1	1.3	0.0	9,800	Analyzed on 8/15/98
CPT-34/ 86 ft	26	2	9/29/98 8:11	-0.075	5.9	0.0	0.0	0.0	10,900	
CPT-4A/ 91 ft	28	2	8/14/98 9:53	0.050	6.9	0.0	1.1	6.5	9,770	Analyzed on 8/15/98
CPT-4A/ 91 ft	28	2	9/29/98 9:55	-0.105	7.7	0.0	0.0	5.5	13,000	
W18-252SST/ 100 ft	30	2	8/14/98 9:18	0.040	8.9	0.0	0.0	0.0	9,640	Analyzed on 8/15/98
W18-252SST/ 100 ft	30	2	9/29/98 9:31	-0.112	17.8	0.0	0.0	0.0	11,400	
W18-152/ 102 ft	31	2	8/14/98 7:44	0.005	11.1	1.4	0.0	0.0	9,670	Analyzed on 8/15/98
W18-152/ 102 ft	31	2	9/29/98 7:43	-0.072	0.0	0.0	0.0	0.0	10,600	
W18-167/ 106 ft	32	3	8/14/98 0:00	--	--	--	--	--	--	No access
W18-167/ 106 ft	32	3	9/29/98 8:56	-0.082	79.7	1.6	0.0	3.2	11,200	
CPT-4F/ 109 ft	33	2	8/14/98 9:41	0.040	6.3	2.6	1.0	1.2	9,790	Analyzed on 8/15/98
CPT-4F/ 109 ft	33	2	9/29/98 9:43	-0.070	13.8	0.0	0.0	0.0	12,500	
W18-174/ 117 ft	36	3	8/14/98 0:00	--	--	--	--	--	--	Not in service
W18-174/ 117 ft	36	3	9/29/98 0:00	--	--	--	--	--	--	Not in service

Table D-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (6 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
W18-158L/ 120 ft	36	3	8/14/98 0:00	--	--	--	--	--	--	No access
W18-158L/ 120 ft	36	3	9/29/98 8:47	-0.082	143.0	0.0	7.7	165.0	11,100	
W18-249/ 130 ft	39	3	8/14/98 0:00	--	--	--	--	--	--	Not in service
W18-249/ 130 ft	39	3	9/29/98 8:33	-0.095	20.4	2.0	1.1	4.8	10,900	
W18-248/ 131 ft	40	3	8/14/98 11:20	0.072	7.1	2.2	0.0	0.0	9,810	Analyzed on 8/15/98
W18-248/ 131 ft	40	3	9/29/98 11:12	-0.075	86.3	2.3	0.0	1.5	14,300	
W18-7/ 197 ft	60	6	12/1/97 0:00	--	--	--	--	--	--	Not in service
W18-7/ 197 ft	60	6	1/10/98 14:45	0.095	12.6	0.0	0.0	0.0	6,180	
W18-7/ 197 ft	60	6	1/29/98 10:09	0.767	14.4	0.0	0.0	0.0	8,130	
W18-7/ 197 ft	60	6	2/26/98 11:25	-0.516	15.7	0.0	0.0	1.5	6,580	
W18-7/ 197 ft	60	6	2/26/98 11:25	-0.516	15.7	0.0	0.0	1.5	6,550	Duplicate
W18-7/ 197 ft	60	6	3/24/98 7:59	0.144	15.8	0.0	0.0	1.5	9,020	
W18-7/ 197 ft	60	6	8/14/98 11:09	0.035	0.0	2.3	1.2	0.0	9,710	Analyzed on 8/15/98
W18-7/ 197 ft	60	6	9/29/98 11:06	-0.192	17.3	0.0	0.0	0.0	14,500	
W18-7/ 197 ft	60	6	9/29/98 11:06	-0.192	17.2	1.2	0.0	0.0	14,400	Duplicate
W18-12/ 198 ft	60	6	8/14/98 12:50	0.391	1.2	2.3	1.0	2.0	9,730	Analyzed on 8/15/98
W18-12/ 198 ft	60	6	9/29/98 10:31	-0.214	3.8	0.0	0.0	9.0	12,200	
W18-6L/ 208 ft	63	6	12/1/97 0:00	--	--	--	--	--	--	Not in service
W18-6L/ 208 ft	63	6	1/10/98 13:50	0.139	24.0	0.0	0.0	2.0	4,700	
W18-6L/ 208 ft	63	6	1/29/98 11:05	0.687	25.8	0.0	0.0	1.9	8,350	
W18-6L/ 208 ft	63	6	2/26/98 12:30	-0.456	31.3	1.0	0.0	1.2	6,830	

Table D-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (6 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
W18-6L/ 208 ft	63	6	3/24/98 10:11	0.167	0.0	3.1	2.3	1.6	9,850	Sampling tube removed, SVE wellhead adapter installed prior to sampling; sampled from wellhead after well had been open to atmosphere for wellhead assembly changeout.
W18-6L/ 208 ft	63	6	8/14/98 10:36	0.252	4.3	1.6	0.0	0.0	9,560	Analyzed on 8/15/98
W18-6L/ 208 ft	63	6	9/29/98 10:21	-0.214	14.5	1.0	0.0	2.2	12,600	

-- = no data

bgs = below ground surface

CCl₄ = carbon tetrachlorideCH₂Cl₂ = methylene chlorideCHCl₃ = chloroform

MEK = methylethyl ketone

ppmv = parts per million by volume

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
86-06/ 5 ft	2	1	12/1/97 12:07	-0.005	0.0	0.0	0.0	0.0	7,340	
86-06/ 5 ft	2	1	1/10/98 9:08	-0.010	0.0	0.0	0.0	0.0	4,150	
86-06/ 5 ft	2	1	1/29/98 8:20	0.005	0.0	0.0	0.0	0.0	7,300	
86-06/ 5 ft	2	1	2/26/98 8:42	-0.010	0.0	0.0	0.0	0.0	5,460	
86-06/ 5 ft	2	1	3/24/98 13:00	0.007	0.0	0.0	0.0	0.0	11,000	
86-06/ 5 ft	2	1	4/30/98 11:06	0.002	0.0	0.0	0.0	0.0	13,100	
86-06/ 5 ft	2	1	5/26/98 9:10	0.005	0.0	0.0	0.0	0.0	8,410	
86-06/ 5 ft	2	1	6/29/98 11:42	0.010	0.0	0.0	0.0	1.6	23,800	
94-09/ 5 ft	2	1	12/1/97 12:35	-0.007	1.3	0.0	0.0	0.0	7,460	
94-09/ 5 ft	2	1	1/10/98 9:22	-0.012	0.0	0.0	0.0	0.0	4,110	
94-09/ 5 ft	2	1	1/29/98 8:40	-0.007	0.0	0.0	0.0	0.0	7,340	
94-09/ 5 ft	2	1	2/26/98 9:02	-0.007	1.3	0.0	0.0	0.0	5,720	
94-09/ 5 ft	2	1	3/24/98 11:51	0.002	0.0	0.0	0.0	0.0	10,600	
94-09/ 5 ft	2	1	4/30/98 11:12	0.007	0.0	0.0	0.0	0.0	13,500	
94-09/ 5 ft	2	1	5/26/98 9:17	-0.002	0.0	0.0	0.0	0.0	8,510	
94-09/ 5 ft	2	1	6/29/98 9:23	0.007	0.0	2.2	0.0	0.0	20,000	
94-09/ 5 ft	2	1	8/14/98 12:08	0.017	0.0	1.3	0.0	0.0	9,750	Analyzed on 8/15/98
94-09/ 5 ft	2	1	9/29/98 11:35	0.007	0.0	1.5	0.0	0.0	21,200	
95-11/ 5 ft	2	1	12/1/97 12:57	-0.007	0.0	0.0	0.0	0.0	7,730	
95-11/ 5 ft	2	1	1/10/98 10:07	-0.010	0.0	0.0	0.0	0.0	4,140	
95-11/ 5 ft	2	1	1/29/98 9:08	0.000	0.0	0.0	0.0	0.0	7,360	
95-11/ 5 ft	2	1	2/26/98 10:22	-0.005	0.0	0.0	0.0	0.0	6,040	

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
95-11/ 5 ft	2	1	3/24/98 11:27	0.000	1.2	0.0	0.0	0.0	10,000	
95-11/ 5 ft	2	1	4/30/98 9:09	0.005	0.0	0.0	0.0	0.0	9,710	
95-11/ 5 ft	2	1	5/26/98 7:36	0.002	2.1	0.0	0.0	0.0	8,440	
95-11/ 5 ft	2	1	6/29/98 7:59	0.005	1.8	1.4	0.0	0.0	15,300	
95-12/ 5 ft	2	1	12/1/97 13:10	-0.007	0.0	0.0	0.0	0.0	7,600	
95-12/ 5 ft	2	1	1/10/98 11:25	-0.010	0.0	0.0	0.0	0.0	4,390	
95-12/ 5 ft	2	1	1/29/98 9:17	-0.010	0.0	0.0	0.0	0.0	7,380	
95-12/ 5 ft	2	1	2/26/98 10:27	-0.005	0.0	0.0	0.0	0.0	6,030	
95-12/ 5 ft	2	1	3/24/98 11:16	0.000	0.0	0.0	0.0	1.3	9,880	
95-12/ 5 ft	2	1	4/30/98 8:25	0.002	1.4	0.0	0.0	1.3	9,240	
95-12/ 5 ft	2	1	5/26/98 7:20	-0.042	1.5	0.0	0.0	0.0	8,400	
95-12/ 5 ft	2	1	6/29/98 7:45	0.000	1.2	2.2	0.0	0.0	16,000	
CPT-16/ 10 ft	3	2	12/1/97 12:50	-0.100	0.0	0.0	0.0	0.0	7,980	
CPT-16/ 10 ft	3	2	1/10/98 9:32	-0.020	0.0	0.0	0.0	0.0	4,200	
CPT-16/ 10 ft	3	2	1/29/98 8:46	-0.012	0.0	0.0	0.0	0.0	7,300	
CPT-16/ 10 ft	3	2	2/26/98 9:09	-0.017	0.0	0.0	0.0	0.0	5,770	
CPT-16/ 10 ft	3	2	3/24/98 11:46	0.012	0.0	0.0	0.0	0.0	11,100	
CPT-16/ 10 ft	3	2	4/30/98 10:41	0.002	0.0	0.0	0.0	0.0	12,700	
CPT-16/ 10 ft	3	2	5/26/98 8:40	0.007	0.0	0.0	0.0	0.0	8,340	
CPT-16/ 10 ft	3	2	6/29/98 9:11	0.002	0.0	0.0	0.0	0.0	16,400	
CPT-17/ 10 ft	3	2	12/1/97 13:17	-0.005	0.0	0.0	0.0	0.0	7,750	
CPT-17/ 10 ft	3	2	1/10/98 11:32	-0.010	0.0	0.0	0.0	0.0	4,500	
CPT-17/ 10 ft	3	2	1/29/98 9:22	-0.020	0.0	0.0	0.0	0.0	7,660	

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-17/ 10 ft	3	2	2/26/98 10:33	-0.002	0.0	0.0	0.0	1.4	6,430	
CPT-17/ 10 ft	3	2	3/24/98 11:13	0.005	1.2	0.0	0.0	1.5	10,400	
CPT-17/ 10 ft	3	2	4/30/98 8:21	0.002	3.6	0.0	0.0	1.8	9,170	
CPT-17/ 10 ft	3	2	5/26/98 7:17	0.005	4.2	1.1	0.0	0.0	8,320	
CPT-17/ 10 ft	3	2	6/29/98 7:41	-0.002	4.1	1.0	0.0	0.0	14,900	
CPT-18/ 15 ft	5	2	12/1/97 13:04	-0.007	0.0	0.0	0.0	0.0	7,830	
CPT-18/ 15 ft	5	2	1/10/98 10:30	-0.010	0.0	0.0	0.0	0.0	4,320	
CPT-18/ 15 ft	5	2	1/29/98 9:03	0.002	0.0	0.0	0.0	0.0	7,510	
CPT-18/ 15 ft	5	2	2/26/98 10:18	-0.007	0.0	0.0	0.0	0.0	5,890	
CPT-18/ 15 ft	5	2	3/24/98 11:30	0.005	0.0	0.0	0.0	0.0	10,600	
CPT-18/ 15 ft	5	2	4/30/98 9:06	0.005	1.0	0.0	0.0	0.0	9,470	
CPT-18/ 15 ft	5	2	5/26/98 7:31	0.012	4.3	0.0	0.0	0.0	8,410	
CPT-18/ 15 ft	5	2	6/29/98 7:56	0.000	6.5	1.7	0.0	0.0	14,900	
CPT-28/ 40 ft	12	2	12/1/97 13:33	-0.010	17.0	0.0	0.0	0.0	7,970	
CPT-28/ 40 ft	12	2	1/10/98 11:48	-0.012	19.1	0.0	0.0	0.0	4,590	
CPT-28/ 40 ft	12	2	1/29/98 9:38	-0.040	21.6	0.0	0.0	0.0	7,810	
CPT-28/ 40 ft	12	2	1/29/98 9:38	-0.040	21.8	0.0	0.0	0.0	7,820	Duplicate
CPT-28/ 40 ft	12	2	2/26/98 10:50	-0.010	19.2	0.0	0.0	1.4	6,250	
CPT-28/ 40 ft	12	2	3/24/98 12:40	0.032	11.7	0.0	0.0	0.0	13,700	
CPT-28/ 40 ft	12	2	4/30/98 7:50	-0.035	13.3	0.0	0.0	0.0	8,490	
CPT-21A/ 45 ft	14	2	12/1/97 13:25	-0.022	18.5	0.0	0.0	1.4	8,040	
CPT-21A/ 45 ft	14	2	1/10/98 11:40	-0.010	30.5	0.0	0.0	2.0	4,600	
CPT-21A/ 45 ft	14	2	1/29/98 9:29	-0.027	37.1	0.0	0.0	1.9	7,750	

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
CPT-21A/ 45 ft	14	2	2/26/98 10:40	-0.037	21.5	0.0	0.0	1.5	6,370	
CPT-21A/ 45 ft	14	2	3/24/98 11:06	0.042	42.9	0.0	0.0	2.2	10,900	
CPT-21A/ 45 ft	14	2	3/24/98 11:06	0.042	43.0	0.0	0.0	2.3	11,000	Duplicate
CPT-21A/ 45 ft	14	2	4/30/98 8:11	-0.045	41.4	0.0	0.0	2.6	9,140	
CPT-21A/ 45 ft	14	2	5/26/98 7:07	0.057	52.7	1.3	0.0	2.1	8,270	
CPT-21A/ 45 ft	14	2	6/29/98 7:33	-0.067	33.7	2.1	0.0	1.0	14,700	
CPT-28/ 60 ft	18	2	5/26/98 6:52	0.015	1.3	0.0	0.0	0.0	8,100	Substituted for CPT-28/40 ft
CPT-28/ 60 ft	18	2	6/29/98 7:23	-0.012	0.0	3.3	0.0	0.0	14,900	Substituted for CPT-28/40 ft
CPT-28/ 60 ft	18	2	8/14/98 11:54	0.027	1.3	0.0	0.0	0.0	9,750	Substituted for CPT-28/40 ft; analyzed on 8/15/98
CPT-28/ 60 ft	18	2	9/29/98 11:28	0.000	1.5	0.0	0.0	0.0	17,400	Substituted for CPT-28/40 ft
CPT-9A/ 60 ft	18	2	12/1/97 12:25	-0.012	35.8	0.0	0.0	2.3	7,310	
CPT-9A/ 60 ft	18	2	12/1/97 12:25	-0.012	35.8	0.0	0.0	2.6	7,300	Duplicate
CPT-9A/ 60 ft	18	2	1/10/98 15:00	-0.040	37.5	0.0	0.0	2.1	5,580	
CPT-9A/ 60 ft	18	2	1/10/98 15:00	-0.040	37.9	0.0	0.0	2.4	5,620	Duplicate
CPT-9A/ 60 ft	18	2	1/29/98 8:30	0.010	39.1	0.0	0.0	2.3	7,330	
CPT-9A/ 60 ft	18	2	2/26/98 8:54	-0.052	40.9	0.0	0.0	2.8	5,510	
CPT-9A/ 60 ft	18	2	3/24/98 12:03	0.037	38.9	0.0	0.0	2.6	11,000	
CPT-9A/ 60 ft	18	2	4/30/98 11:19	0.007	39.1	0.0	0.0	2.3	13,700	
CPT-9A/ 60 ft	18	2	5/26/98 9:24	0.065	38.8	0.0	0.0	3.7	8,360	
CPT-9A/ 60 ft	18	2	6/29/98 9:30	0.000	38.0	1.3	0.0	1.8	20,200	
CPT-9A/ 60 ft	18	2	8/14/98 12:20	0.080	30.4	0.0	0.0	2.2	9,660	Analyzed on 8/15/98
CPT-9A/ 60 ft	18	2	9/29/98 11:41	0.007	41.1	0.0	0.0	1.0	17,700	

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-24/ 70 ft	21	2	4/30/98 10:28	-0.005	1.8	0.0	0.0	0.0	13,800	Substituted for CPT-24/ 95 ft
CPT-24/ 70 ft	21	2	5/26/98 7:42	0.112	3.2	0.0	0.0	1.7	8,420	Substituted for CPT-24/ 95 ft
CPT-24/ 70 ft	21	2	6/29/98 8:04	-0.060	2.9	0.0	0.0	0.0	15,400	Substituted for CPT-24/ 95 ft
CPT-21A/ 86 ft	26	2	4/30/98 8:15	-0.087	169.0	1.5	0.0	3.1	9,220	
CPT-21A/ 86 ft	26	2	5/26/98 7:12	0.115	168.0	0.0	0.0	3.6	8,230	
CPT-21A/ 86 ft	26	2	6/29/98 7:36	-0.127	206.0	7.5	2.7	3.1	14,500	
W15-95/ 87 ft	26	2	4/30/98 9:44	-0.022	11.9	0.0	0.0	0.0	12,000	Sampled from wellhead without tubing after 3-minute purge
W15-95/ 87 ft	26	2	5/26/98 8:21	0.144	15.0	0.0	0.0	1.5	8,520	Sampled from wellhead without tubing after 3-minute purge
W15-95/ 87 ft	26	2	6/29/98 8:45	-0.075	15.3	1.7	0.0	0.0	19,000	Sampled from wellhead without tubing after 3-minute purge
CPT-28/ 87 ft	27	2	4/30/98 8:04	-0.087	229.0	1.6	0.0	2.4	9,050	
CPT-28/ 87 ft	27	2	5/26/98 7:00	0.110	229.0	1.8	0.0	1.7	8,160	
CPT-28/ 87 ft	27	2	6/29/98 7:26	-0.130	230.0	2.8	0.0	1.3	14,500	
W15-82/ 88 ft	27	2	4/30/98 10:51	0.007	0.0	0.0	0.0	0.0	13,000	Sampled from wellhead without tubing after 3-minute purge
W15-82/ 88 ft	27	2	5/26/98 8:50	0.137	5.5	0.0	0.0	5.5	8,450	Sampled from wellhead without tubing after 3-minute purge
W15-82/ 88 ft	27	2	6/29/98 11:33	0.015	0.0	0.0	0.0	2.3	19,000	Sampled from wellhead without tubing after 3-minute purge
CPT-9A/ 91 ft	28	2	4/30/98 11:24	0.002	27.6	0.0	0.0	1.9	10,500	
CPT-9A/ 91 ft	28	2	5/26/98 9:29	0.067	34.5	0.0	0.0	3.2	8,190	
CPT-9A/ 91 ft	28	2	6/29/98 9:35	-0.045	33.6	0.0	0.0	1.7	15,800	

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
W15-218U/ 106 ft	32	3	4/30/98 10:03	0.080	0.0	0.0	0.0	1.1	12,900	Sampled from wellhead without tubing after 3-minute purge
W15-218U/ 106 ft	32	3	4/30/98 10:10	0.080	0.0	0.0	0.0	0.0	12,400	Sampled from wellhead without tubing after 10-minute purge
W15-218U/ 106 ft	32	3	5/26/98 8:06	0.229	0.0	0.0	0.0	0.0	8,300	Sampled from wellhead without tubing after 3-minute purge
W15-218U/ 106 ft	32	3	5/26/98 8:11	0.229	0.0	0.0	0.0	0.0	8,270	Sampled from wellhead without tubing after 10-minute purge
W15-218U/ 106 ft	32	3	6/29/98 8:36	-0.227	0.0	1.9	0.0	0.0	18,000	Sampled from wellhead without tubing after 3-minute purge
W15-223/ 110 ft	34	3	4/30/98 10:22	0.010	0.0	0.0	0.0	0.0	15,000	Sampled from wellhead without tubing after 3-minute purge
W15-223/ 110 ft	34	3	5/26/98 7:55	0.154	2.2	0.0	0.0	0.0	8,340	Sampled from wellhead without tubing after 3-minute purge
W15-223/ 110 ft	34	3	6/29/98 8:25	-0.085	0.0	0.0	0.0	0.0	12,900	Sampled from wellhead without tubing after 3-minute purge
W15-217/ 114 ft	35	3	3/24/98 11:22	0.077	95.7	0.0	0.0	0.0	9,510	Sampled from wellhead without tubing after 3-minute purge
W15-217/ 114 ft	35	3	4/30/98 8:52	-0.057	18.8	0.0	0.0	0.0	8,880	Sampled from wellhead without tubing after 3-minute purge
W15-217/ 114 ft	35	3	4/30/98 8:59	-0.057	25.4	1.0	0.0	0.0	8,770	Sampled from wellhead without tubing after 10 minute purge
W15-217/ 114 ft	35	3	5/26/98 7:25	0.174	630.0	5.2	0.0	0.0	8,480	Tubing installed 5/19/98
W15-217/ 114 ft	35	3	5/26/98 7:25	0.174	458.0	5.3	0.0	1.4	8,480	Duplicate
W15-217/ 114 ft	35	3	6/29/98 7:50	-0.157	504.0	4.2	0.0	1.2	14,400	
CPT-24/ 118 ft	36	3	4/30/98 9:30	-0.080	37.7	1.6	1.6	2.9	10,200	

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
CPT-24/ 118 ft	36	3	4/30/98 9:30	-0.080	38.0	1.7	1.6	2.6	9,710	Duplicate
CPT-24/ 118 ft	36	3	5/26/98 7:48	0.224	36.5	0.0	0.0	2.7	8,420	
CPT-24/ 118 ft	36	3	6/29/98 8:08	-0.172	37.5	1.8	1.2	3.0	15,700	
CPT-24/ 118 ft	36	3	6/29/98 8:08	-0.172	37.8	1.9	1.4	2.3	15,700	Duplicate
W15-9L/ 176 ft	53	6	12/1/97 0:00	--	--	--	--	--	--	Not in service
W15-9L/ 176 ft	53	6	1/10/98 15:10	0.050	13.3	0.0	0.0	1.3	5,680	
W15-9L/ 176 ft	53	6	1/29/98 0:00	--	--	--	--	--	--	Unable to sample; radiological concern
W15-9L/ 176 ft	53	6	2/5/98 8:00	-0.740	14.6	0.0	0.0	1.3	7,940	
W15-9L/ 176 ft	53	6	2/5/98 8:00	-0.740	14.6	0.0	0.0	1.1	7,970	Duplicate
W15-9L/ 176 ft	53	6	2/26/98 9:34	-0.543	8.7	0.0	0.0	1.2	5,810	
W15-9L/ 176 ft	53	6	3/24/98 11:35	0.204	14.6	0.0	0.0	1.7	9,780	
W15-9L/ 176 ft	53	6	4/30/98 9:52	0.092	14.0	0.0	0.0	1.6	10,900	
W15-9L/ 176 ft	53	6	5/26/98 8:27	0.254	15.0	0.0	0.0	2.4	8,420	
W15-9L/ 176 ft	53	6	6/29/98 8:51	-0.249	8.6	2.0	0.0	0.0	18,800	
W15-216L/ 180 ft	55	5	12/1/97 0:00	--	--	--	--	--	--	Not in service
W15-216L/ 180 ft	55	5	1/10/98 8:54	-0.095	14.1	0.0	0.0	0.0	4,190	
W15-216L/ 180 ft	55	5	1/29/98 8:11	0.177	15.5	0.0	0.0	0.0	7,380	
W15-216L/ 180 ft	55	5	2/26/98 8:33	-0.568	15.0	0.0	0.0	1.2	5,630	
W15-216L/ 180 ft	55	5	3/24/98 12:52	0.291	17.3	0.0	0.0	0.0	13,400	
W15-216L/ 180 ft	55	5	4/30/98 11:00	0.012	15.0	1.1	1.0	0.0	14,100	
W15-216L/ 180 ft	55	5	5/26/98 8:59	0.120	15.3	0.0	0.0	1.6	8,480	
W15-216L/ 180 ft	55	5	6/29/98 11:38	-0.012	12.8	3.4	1.9	4.1	21,500	
W15-6L/ 182 ft	55	6	12/1/97 0:00	--	--	--	--	--	--	Not in service

Table D-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1997 Through September 1998. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
W15-6L/ 182 ft	55	6	1/10/98 9:52	-0.067	15.2	0.0	0.0	1.9	5,620	
W15-6L/ 182 ft	55	6	1/29/98 8:53	0.807	16.1	0.0	0.0	2.2	7,490	
W15-6L/ 182 ft	55	6	2/26/98 9:20	-0.545	16.1	0.0	0.0	2.8	5,860	
W15-6L/ 182 ft	55	6	3/24/98 11:40	0.214	16.3	0.0	0.0	2.0	11,100	
W15-6L/ 182 ft	55	6	4/30/98 10:36	0.095	16.4	0.0	0.0	2.3	14,400	
W15-6L/ 182 ft	55	6	5/26/98 8:34	0.252	17.8	0.0	0.0	2.2	8,470	
W15-6L/ 182 ft	55	6	6/29/98 8:57	-0.252	17.6	1.6	0.0	2.5	18,200	

-- = no data

bgs = below ground surface

CCl₄ = carbon tetrachlorideCH₂Cl₂ = methylene chlorideCHCl₃ = chloroform

MEK = methylethyl ketone

ppmv = parts per million by volume

Table D-3. Carbon Tetrachloride Concentration Standard Analyses, October 1997 Through September 1998.

Carbon Tetrachloride Concentration Standard (ppmv)	Carbon Tetrachloride Concentration Analyzed (ppmv)	Date Analyzed	Time Analyzed	B&K Serial Number
27.6	24.9	12/01/97	15:32	1747619
27.6	24.3	01/10/98	15:29	1747619
27.6	24.0	01/29/98	12:40	1747619
27.6	24.1	02/05/98	8:36	1747619
27.6	25.2	02/26/98	14:04	1747619
27.6	23.9	03/25/98	9:32	1747619
27.6	24.6	04/30/98	11:54	1747619
27.6	23.3	05/26/98	15:57	1732828
27.6	23.2	06/29/98	9:56	1732828
25.5	24.6	08/14/98	7:19	1715232
25.5	25.5	08/14/98	8:08	1715232
25.5	25.4	09/29/98	11:59	1715232
25.5	25.4	09/29/98	12:55	1715232

Table D-4. Blank Analyses^a, October 1997 Through September 1998. (2 Pages)

Sample Location	Sample Date	Sample Time	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)
Blank	12/01/97	15:30	0.00	0.00	0.00	0.00	6,810
Blank	12/01/97	16:19	0.00	0.00	0.00	0.00	7,200
Blank	01/10/98	15:25	0.00	0.00	0.00	0.00	5,000
Blank	01/10/98	16:21	0.00	0.00	0.00	0.00	4,020
Blank	01/29/98	12:38	0.00	0.00	0.00	0.00	7,300
Blank	01/29/98	13:36	0.00	0.00	0.00	0.00	8,160
Blank	02/05/98	8:34	0.00	0.00	0.00	0.00	7,850
Blank	02/05/98	8:42	0.00	0.00	0.00	0.00	8,050
Blank	02/26/98	14:02	0.00	0.00	0.00	0.00	5,720
Blank	02/26/98	14:56	0.00	0.00	0.00	0.00	5,080
Blank	03/24/98	13:05	0.00	0.00	0.00	0.00	8,190
Blank	03/24/98	14:01	0.00	0.00	0.00	0.00	7,770
Blank	04/30/98	11:52	0.00	0.00	0.00	0.00	11,700
Blank	04/30/98	12:52	0.00	0.00	0.00	0.00	8,320
Blank	05/26/98	15:59	0.00	1.47	0.00	0.00	8,970
Blank	05/26/98	16:57	0.00	0.00	0.00	0.00	8,510

Appendix D – FY 1998 Soil Vapor Monitoring Data

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Table D-4. Blank Analyses^a, October 1997 Through September 1998. (2 Pages)

Sample Location	Sample Date	Sample Time	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)
Blank	06/29/98	9:53	0.00	0.00	0.00	0.00	8,790
Blank	06/29/98	10:44	0.00	0.00	0.00	0.00	11,700
Blank	06/29/98	11:53	0.00	0.00	0.00	0.00	9,180
Blank	06/29/98	12:01	0.00	0.00	0.00	0.00	11,000
Blank	08/14/98	7:20	0.00	0.00	0.00	0.00	9,100
Blank	08/14/98	8:10	0.00	0.00	0.00	0.00	10,500
Blank	09/29/98	11:57	0.00	0.00	0.00	0.00	9,480
Blank	09/29/98	12:57	0.00	0.00	0.00	0.00	9,470

^a Analyses of the vapor headspace in blank samples of deionized water.

CCl4 = carbon tetrachloride

CHCl3 = chloroform

MEK = methylethyl ketone

CH2Cl2 = methylene chloride

APPENDIX E

FISCAL YEAR 1999 SOIL VAPOR MONITORING DATA

Table E-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
79-03/ 5 ft	2	1	4/26/1999 8:36	-0.002	0.0	0.0	0.0	0.0	5,400		
79-03/ 5 ft	2	1	5/25/1999 8:03	0.005	0.0	0.0	0.0	0.0	9,910		
79-03/ 5 ft	2	1	6/28/1999 7:44	0.002	0.0	0.0	0.0	0.0	10,400		
79-06/ 5 ft	2	1	11/5/1998 8:30	-0.025	0.0	0.0	0.0	0.0	13,400		
79-06/ 5 ft	2	1	12/1/1998 8:07	-0.090	0.0	0.0	0.0	0.0	7,490		
79-06/ 5 ft	2	1	12/31/1998 8:05	-0.110	0.0	0.0	0.0	0.0	9,080		
79-06/ 5 ft	2	1	1/26/1999 7:51	-0.057	0.0	0.0	0.0	0.0	5,880		
79-06/ 5 ft	2	1	2/23/1999 9:09	-0.007	1.2	0.0	0.0	0.0	7,930		
79-06/ 5 ft	2	1	3/22/1999 8:39	0.002	0.0	0.0	0.0	0.0	8,680		
79-06/ 5 ft	2	1	4/26/1999 10:38	0.002	0.0	0.0	0.0	0.0	7,210		
79-06/ 5 ft	2	1	5/25/1999 9:40	0.005	1.4	0.0	0.0	0.0	10,400		
79-06/ 5 ft	2	1	6/28/1999 9:14	0.005	1.2	0.0	0.0	0.0	13,000		
79-11/ 5 ft	2	1	11/5/1998 9:02	0.000	2.8	0.0	0.0	0.0	13,100		
79-11/ 5 ft	2	1	12/1/1998 8:38	-0.005	0.0	0.0	0.0	0.0	7,610		
79-11/ 5 ft	2	1	12/31/1998 8:23	-0.005	2.9	0.0	0.0	0.0	9,040		
79-11/ 5 ft	2	1	1/26/1999 8:17	-0.015	1.9	0.0	0.0	0.0	6,010		
79-11/ 5 ft	2	1	2/23/1999 9:30	0.000	1.6	0.0	0.0	0.0	8,210		
79-11/ 5 ft	2	1	3/22/1999 9:30	0.005	2.5	0.0	0.0	0.0	9,530		
79-11/ 5 ft	2	1	4/26/1999 11:04	-0.057	1.5	0.0	0.0	0.0	8,100		
79-11/ 5 ft	2	1	5/25/1999 11:00	0.005	1.4	0.0	0.0	0.0	14,500		
79-11/ 5 ft	2	1	6/28/1999 9:32	0.005	0.0	0.0	0.0	0.0	14,600		
87-05/ 5 ft	2	1	4/26/1999 10:48	0.005	1.0	0.0	0.0	0.0	7,670		
87-05/ 5 ft	2	1	5/25/1999 10:47	-0.005	1.0	0.0	0.0	0.0	12,300		
87-05/ 5 ft	2	1	6/28/1999 9:25	0.002	0.0	0.0	0.0	0.0	13,600		
87-09/ 5 ft	2	1	11/5/1998 9:29	0.000	0.0	0.0	0.0	0.0	12,900		

Table E-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment	CO ₂ (%)
87-09/ 5 ft	2	1	12/1/1998 9:11	0.000	0.0	0.0	0.0	0.0	7,770		
87-09/ 5 ft	2	1	12/31/1998 8:46	-0.010	1.1	0.0	0.0	0.0	8,870		
87-09/ 5 ft	2	1	1/26/1999 8:45	-0.015	0.0	0.0	0.0	0.0	6,100		
87-09/ 5 ft	2	1	2/23/1999 9:49	0.002	0.0	0.0	0.0	0.0	8,380		
87-09/ 5 ft	2	1	3/22/1999 9:55	-0.115	1.2	0.0	0.0	0.0	9,890		
87-09/ 5 ft	2	1	4/26/1999 11:26	0.002	2.6	0.0	0.0	0.0	8,790		
87-09/ 5 ft	2	1	5/25/1999 11:20	0.045	2.4	0.0	0.0	0.0	19,800		
87-09/ 5 ft	2	1	6/28/1999 9:53	0.005	2.3	0.0	0.0	0.0	16,000		
CPT-13A/ 9 ft	3	2	4/26/1999 11:10	0.010	0.0	0.0	0.0	0.0	8,040		
CPT-13A/ 9 ft	3	2	5/25/1999 11:04	-0.005	1.0	0.0	0.0	0.0	13,700		
CPT-13A/ 9 ft	3	2	6/28/1999 9:37	0.007	0.0	0.0	0.0	0.0	12,200		
CPT-31/ 25 ft	8	2	4/26/1999 10:15	0.002	0.0	0.0	0.0	0.0	6,380		
CPT-31/ 25 ft	8	2	5/25/1999 8:52	-0.002	0.0	0.0	0.0	0.0	10,600		
CPT-31/ 25 ft	8	2	6/28/1999 8:26	0.000	0.0	0.0	0.0	0.0	10,800		
CPT-32/ 25 ft	8	2	11/5/1998 8:37	0.000	1.0	1.1	0.0	0.0	12,700		
CPT-32/ 25 ft	8	2	12/1/1998 8:15	-0.015	2.1	0.0	0.0	0.0	7,490		
CPT-32/ 25 ft	8	2	12/31/1998 8:11	-0.010	5.2	0.0	0.0	0.0	8,920		
CPT-32/ 25 ft	8	2	1/26/1999 8:02	-0.020	7.0	0.0	0.0	0.0	5,660		
CPT-32/ 25 ft	8	2	2/23/1999 9:15	0.000	7.4	0.0	0.0	0.0	8,150		
CPT-32/ 25 ft	8	2	3/22/1999 8:46	0.005	8.3	0.0	0.0	0.0	8,950		
CPT-32/ 25 ft	8	2	4/26/1999 10:43	0.000	10.0	0.0	0.0	0.0	7,770		
CPT-32/ 25 ft	8	2	5/25/1999 9:45	-0.002	9.1	0.0	0.0	0.0	11,400		
CPT-32/ 25 ft	8	2	6/28/1999 9:20	0.007	8.4	0.0	0.0	0.0	12,200		
CPT-30/ 28 ft	9	2	11/5/1998 8:04	-0.002	0.0	1.1	0.0	0.0	12,600		
CPT-30/ 28 ft	9	2	12/1/1998 7:46	-0.005	0.0	0.0	0.0	0.0	7,410		
CPT-30/ 28 ft	9	2	12/31/1998 7:47	-0.007	0.0	0.0	0.0	0.0	8,860		

Table E-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
CPT-30/ 28 ft	9	2	1/26/1999 7:35	-0.022	0.0	0.0	0.0	0.0	5,640		
CPT-30/ 28 ft	9	2	2/23/1999 8:52	0.010	0.0	0.0	0.0	0.0	7,920		
CPT-30/ 28 ft	9	2	3/22/1999 8:23	-0.139	0.0	0.0	0.0	0.0	8,720		
CPT-30/ 28 ft	9	2	4/26/1999 10:02	-0.189	3.2	0.0	0.0	0.0	6,590		
CPT-30/ 28 ft	9	2	5/25/1999 8:39	-0.005	0.0	0.0	0.0	0.0	10,300		
CPT-30/ 28 ft	9	2	6/28/1999 8:10	-0.005	0.0	0.0	0.0	0.0	10,600		
CPT-7A/ 32 ft	10	2	11/5/1998 9:43	-0.005	1.7	0.0	0.0	0.0	13,300		
CPT-7A/ 32 ft	10	2	12/1/1998 9:17	0.000	2.4	0.0	0.0	0.0	7,990		
CPT-7A/ 32 ft	10	2	12/31/1998 8:51	-0.025	2.6	0.0	0.0	0.0	8,830		
CPT-7A/ 32 ft	10	2	1/26/1999 9:13	-0.040	5.4	0.0	0.0	0.0	6,260		
CPT-7A/ 32 ft	10	2	2/23/1999 9:55	0.015	3.5	0.0	0.0	0.0	8,300		
CPT-7A/ 32 ft	10	2	3/22/1999 10:01	0.022	3.5	0.0	0.0	0.0	9,630		
CPT-7A/ 32 ft	10	2	4/26/1999 11:31	0.005	3.2	0.0	0.0	0.0	8,720		
CPT-7A/ 32 ft	10	2	5/25/1999 11:24	0.005	3.7	0.0	0.0	0.0	21,300		
CPT-7A/ 32 ft	10	2	6/28/1999 9:58	0.017	2.6	0.0	0.0	0.0	15,000		
CPT-1A/ 35 ft	11	2	4/26/1999 8:21	-0.002	2.8	0.0	0.0	0.0	5,140		
CPT-1A/ 35 ft	11	2	5/25/1999 7:53	-0.017	3.0	0.0	0.0	0.0	10,000		
CPT-1A/ 35 ft	11	2	6/28/1999 7:30	-0.002	2.1	0.0	0.0	0.0	9,540		
CPT-33/ 40 ft	12	2	4/26/1999 9:09	-0.002	2.3	0.0	0.0	0.0	5,440		
CPT-33/ 40 ft	12	2	5/25/1999 8:27	-0.027	2.6	0.0	0.0	0.0	10,300		
CPT-33/ 40 ft	12	2	6/28/1999 7:59	-0.005	2.1	0.0	0.0	0.0	10,100		
CPT-34/ 40 ft	12	2	4/26/1999 8:44	-0.080	1.3	0.0	0.0	0.0	5,410		
CPT-34/ 40 ft	12	2	5/25/1999 8:10	-0.007	1.4	0.0	0.0	0.0	9,990		
CPT-34/ 40 ft	12	2	6/28/1999 7:51	-0.005	1.5	0.0	0.0	0.0	10,500		
CPT-34/ 40 ft	12	2	7/30/1999 7:22	-0.012	1.7	0.0	0.0	0.0	13,100		
CPT-34/ 40 ft	12	2	9/14/1999 8:59	-0.002	1.1	0.0	0.0	0.0	8,680		0.0

Table E-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
CPT-34/ 40 ft	12	2	9/28/1999 8:48	-0.020	1.1	0.0	0.0	0.0	5,660		
CPT-30/ 68 ft	21	2	4/26/1999 10:09	0.015	3.0	1.0	0.0	1.7	6,240		
CPT-30/ 68 ft	21	2	5/25/1999 8:45	-0.060	1.6	0.0	0.0	1.5	9,940		
CPT-30/ 68 ft	21	2	6/28/1999 8:15	-0.012	1.7	0.0	0.0	1.4	9,470		
CPT-13A/ 70 ft	21	2	4/26/1999 11:14	0.020	5.3	0.0	0.0	0.0	8,140		
CPT-13A/ 70 ft	21	2	5/25/1999 11:08	-0.007	5.4	0.0	0.0	0.0	16,300		
CPT-13A/ 70 ft	21	2	6/28/1999 9:41	-0.012	5.6	0.0	0.0	0.0	14,400		
CPT-31/ 76 ft	23	2	4/26/1999 10:20	-0.057	4.2	1.4	0.0	0.0	6,580		
CPT-31/ 76 ft	23	2	5/25/1999 8:56	-0.122	2.2	0.0	0.0	0.0	10,500		
CPT-31/ 76 ft	23	2	6/28/1999 8:30	-0.032	3.2	0.0	0.0	0.0	10,800		
CPT-33/ 80 ft	24	2	4/26/1999 9:13	-0.062	7.6	1.5	0.0	1.0	5,710		
CPT-33/ 80 ft	24	2	5/25/1999 8:32	-0.192	8.5	0.0	0.0	1.0	10,600		
CPT-33/ 80 ft	24	2	6/28/1999 8:03	-0.042	9.2	1.0	0.0	0.0	10,600		
CPT-34/ 86 ft	26	2	4/26/1999 8:56	-0.127	0.0	5.2	2.6	2.7	4,380	Sample very difficult to pull, approx. 1/8-L purge and sample	
CPT-34/ 86 ft	26	2	5/25/1999	-0.050	--	--	--	--	--	Unable to pull sample from CPT-34/ 86 ft or CPT-34/ 60 ft	
CPT-34/ 86 ft	26	2	6/28/1999	-0.027	--	--	--	--	--	Unable to pull sample from CPT-34/ 86 ft or CPT-34/ 60 ft	
CPT-1A/ 91 ft	28	2	4/26/1999 8:27	-0.005	4.2	0.0	0.0	0.0	4,680		
CPT-1A/ 91 ft	28	2	5/25/1999 7:57	0.007	0.0	0.0	0.0	0.0	9,410		
CPT-1A/ 91 ft	28	2	6/28/1999 7:35	0.002	2.4	0.0	0.0	0.0	8,820		
CPT-1A/ 91 ft	28	2	7/30/1999 7:14	-0.002	2.1	0.0	0.0	0.0	12,100		
CPT-1A/ 91 ft	28	2	9/14/1999 8:47	-0.007	3.3	1.3	0.0	3.1	8,500		0.0
CPT-1A/ 91 ft	28	2	9/28/1999 8:38	-0.015	0.0	0.0	0.0	0.0	5,360		
CPT-4A/ 91 ft	28	2	4/26/1999 10:29	-0.002	10.9	0.0	0.0	3.1	7,200		
CPT-4A/ 91 ft	28	2	5/25/1999 9:30	-0.164	14.1	0.0	0.0	3.3	10,300		

Table E-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
CPT-4A/ 91 ft	28	2	5/25/1999 9:30	-0.164	14.1	0.0	0.0	3.4	10,200	Duplicate	
CPT-4A/ 91 ft	28	2	6/28/1999 9:05	-0.057	14.4	0.0	0.0	2.6	11,500		
W18-252SST/ 100 ft	30	2	11/5/1998 8:21	0.045	18.2	0.0	0.0	0.0	14,200		
W18-252SST/ 100 ft	30	2	12/1/1998 7:55	-0.247	13.3	0.0	0.0	0.0	7,610		
W18-252SST/ 100 ft	30	2	12/31/1998 7:55	0.040	22.7	0.0	0.0	0.0	9,100		
W18-252SST/ 100 ft	30	2	1/26/1999 7:43	-0.022	10.7	0.0	0.0	0.0	5,940		
W18-252SST/ 100 ft	30	2	2/23/1999 8:59	0.015	24.0	0.0	0.0	0.0	8,050		
W18-252SST/ 100 ft	30	2	3/22/1999 8:31	0.015	23.2	0.0	0.0	0.0	8,710		
W18-152/ 113 ft	34	2	11/5/1998 7:44	0.050	27.9	0.0	0.0	0.0	13,400		
W18-152/ 113 ft	34	2	12/1/1998 7:23	-0.281	3.4	0.0	0.0	0.0	7,530		
W18-152/ 113 ft	34	2	12/31/1998 7:25	0.022	25.2	0.0	0.0	0.0	8,890		
W18-152/ 113 ft	34	2	1/26/1999 7:20	-0.077	31.7	0.0	0.0	0.0	5,920		
W18-152/ 113 ft	34	2	2/23/1999 8:34	-0.005	33.3	0.0	0.0	1.9	7,960		
W18-152/ 113 ft	34	2	3/22/1999 8:06	0.010	3.3	0.0	0.0	0.0	8,810		
W18-152/ 113 ft	34	2	3/22/1999 8:06	0.010	3.1	0.0	0.0	0.0	8,640	Duplicate	
W18-152/ 113 ft	34	2	4/26/1999 8:14	-0.055	4.7	0.0	0.0	0.0	5,090		
W18-152/ 113 ft	34	2	5/25/1999 7:45	-0.162	4.4	0.0	0.0	0.0	10,100		
W18-152/ 113 ft	34	2	6/28/1999 7:24	-0.017	2.0	0.0	0.0	0.0	9,490		
W18-158L/ 123 ft	37	3	11/5/1998 9:57	0.017	172.0	0.0	5.8	167.0	14,200		
W18-158L/ 123 ft	37	3	12/1/1998 11:58	-0.032	172.0	0.0	4.5	123.0	9,000		
W18-158L/ 123 ft	37	3	12/31/1998	--	--	--	--	--	--	Unable to gain access to Z-1A crib to sample	
W18-158L/ 123 ft	37	3	1/26/1999 8:55	-0.144	267.0	0.0	4.3	118.0	6,230		
W18-158L/ 123 ft	37	3	2/23/1999 11:16	0.065	288.0	0.0	4.3	116.0	9,950		
W18-158L/ 123 ft	37	3	3/22/1999 9:12	0.015	399.0	1.4	4.2	127.0	8,900		
W18-158L/ 123 ft	37	3	4/26/1999 9:47	-0.037	492.0	0.0	5.5	132.0	6,180		
W18-158L/ 123 ft	37	3	5/25/1999 9:12	-0.167	329.0	0.0	5.5	137.0	10,400		

Table E-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
W18-158L/ 123 ft	37	3	6/28/1999 8:40	-0.052	310.0	0.0	5.8	142.0	10,600		
W18-167/ 123 ft	37	3	11/5/1998 10:05	0.007	127.0	1.3	0.0	4.4	13,800		
W18-167/ 123 ft	37	3	12/1/1998 12:06	-0.025	205.0	1.9	0.0	5.9	9,310		
W18-167/ 123 ft	37	3	12/31/1998	--	--	--	--	--	--	Unable to gain access to Z-1A crib to sample	
W18-167/ 123 ft	37	3	1/26/1999 9:06	-0.164	228.0	1.8	0.0	4.2	6,340		
W18-167/ 123 ft	37	3	2/23/1999 11:22	0.075	218.0	2.1	0.0	3.2	10,300		
W18-167/ 123 ft	37	3	3/22/1999 9:19	0.040	195.0	1.9	0.0	5.1	9,060		
W18-167/ 123 ft	37	3	4/26/1999 9:52	-0.030	211.0	1.4	0.0	5.6	6,010		
W18-167/ 123 ft	37	3	5/25/1999 9:17	-0.147	219.0	1.4	0.0	5.1	10,800		
W18-167/ 123 ft	37	3	6/28/1999 8:45	-0.055	173.0	1.2	0.0	5.8	11,100		
W18-167/ 123 ft	37	3	6/28/1999 8:45	-0.055	174.0	1.4	0.0	4.4	11,100	Duplicate	
W18-249/ 134 ft	41	3	11/5/1998 8:53	0.037	215.0	2.3	0.0	0.0	14,100		
W18-249/ 134 ft	41	3	12/1/1998 8:22	-0.269	23.3	0.0	0.0	0.0	7,720		
W18-249/ 134 ft	41	3	12/31/1998 8:17	0.012	208.0	1.5	0.0	0.0	8,920		
W18-249/ 134 ft	41	3	1/26/1999 8:08	-0.105	188.0	0.0	0.0	1.6	6,110		
W18-249/ 134 ft	41	3	2/23/1999 9:21	0.000	139.0	0.0	0.0	1.5	8,350		
W18-249/ 134 ft	41	3	3/22/1999 8:54	0.017	76.9	1.2	0.0	0.0	8,770		
W18-249/ 134 ft	41	3	4/26/1999 10:55	0.000	81.1	0.0	0.0	0.0	6,730		
W18-249/ 134 ft	41	3	5/25/1999 10:52	-0.112	77.1	0.0	0.0	0.0	12,400		
W18-249/ 134 ft	41	3	6/28/1999 8:54	-0.065	90.9	0.0	0.0	0.0	10,400		
W18-248/ 136 ft	41	3	11/5/1998 9:09	0.085	93.5	2.0	0.0	1.3	13,800		
W18-248/ 136 ft	41	3	12/1/1998 8:48	-0.374	98.0	1.4	0.0	2.2	7,900		
W18-248/ 136 ft	41	3	12/31/1998 8:29	0.085	138.0	1.3	0.0	1.7	8,980		
W18-248/ 136 ft	41	3	1/26/1999 8:24	-0.090	136.0	1.1	0.0	1.5	6,240		
W18-248/ 136 ft	41	3	2/23/1999 9:37	0.015	148.0	1.2	0.0	1.5	8,460		
W18-248/ 136 ft	41	3	3/22/1999 9:36	0.020	144.0	1.4	0.0	1.2	9,170		

Table E-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (8 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
W18-248/ 136 ft	41	3	4/26/1999 11:20	-0.012	162.0	1.5	0.0	2.0	7,660		
W18-248/ 136 ft	41	3	5/25/1999 11:14	-0.125	177.0	2.3	0.0	1.1	16,200		
W18-248/ 136 ft	41	3	6/28/1999 9:48	-0.077	152.0	1.2	0.0	1.3	13,500		
W18-6L/ 201 ft	61	6	11/5/1998	--	--	--	--	--	--	W18-6L found with tubing cut	
W18-6L/ 201 ft	61	6	12/1/1998	--	--	--	--	--	--	Not in service	
W18-6L/ 201 ft	61	6	12/31/1998	--	--	--	--	--	--	Not in service	
W18-6L/ 201 ft	61	6	1/26/1999	--	--	--	--	--	--	Not in service	
W18-6L/ 201 ft	61	6	2/23/1999	--	--	--	--	--	--	Not in service	
W18-6L/ 201 ft	61	6	3/22/1999	--	--	--	--	--	--	Not in service	
W18-7/ 203 ft	62	6	11/5/1998 9:23	0.351	22.5	0.0	0.0	0.0	13,700		
W18-7/ 203 ft	62	6	12/1/1998 8:54	-0.518	21.8	0.0	0.0	1.1	7,850		
W18-7/ 203 ft	62	6	12/31/1998 8:35	0.413	26.7	0.0	0.0	0.0	8,990		
W18-7/ 203 ft	62	6	1/26/1999 8:31	0.035	26.4	0.0	0.0	0.0	6,270		
W18-7/ 203 ft	62	6	2/23/1999 9:42	0.072	28.4	0.0	0.0	0.0	8,590		
W18-7/ 203 ft	62	6	3/22/1999 9:42	-0.162	29.0	0.0	0.0	0.0	9,540		
W18-12/ 210 ft	64	6	11/5/1998 7:53	0.418	7.5	0.0	0.0	7.3	13,700		
W18-12/ 210 ft	64	6	12/1/1998 7:35	-0.508	12.0	0.0	0.0	5.9	7,560		
W18-12/ 210 ft	64	6	12/31/1998 7:40	0.481	13.6	0.0	0.0	7.1	9,100		
W18-12/ 210 ft	64	6	1/26/1999 7:27	0.329	12.2	0.0	0.0	5.8	6,030		
W18-12/ 210 ft	64	6	2/23/1999 8:43	0.047	18.5	0.0	0.0	4.7	8,050		
W18-12/ 210 ft	64	6	3/22/1999 8:14	-0.274	15.9	0.0	0.0	3.5	8,620		

-- = no data

bgs = below ground surface

CCl4 = carbon tetrachloride

CH2Cl2 = methylene chloride

CHCl3 = chloroform

CO2 = carbon dioxide

MEK = methylethyl ketone

ppmv = parts per million by volume

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment	CO ₂ (%)
86-05/ 5 ft	2	1	7/30/1999	--	--	--	--	--	--	SGP 86-05 destroyed	
86-05/ 5 ft	2	1	9/28/1999 9:33	0.000	0.0	0.0	0.0	0.0	6,450		
86-05-01/ 5 ft	2	1	9/14/1999	--	--	--	--	--	--	Unable to locate sample point	
86-06/ 5 ft	2	1	12/1/1998 10:52	0.005	0.0	0.0	0.0	0.0	8,420	Substitute for 86-07R	
86-06/ 5 ft	2	1	12/31/1998 10:15	-0.007	0.0	0.0	0.0	0.0	9,890		
86-06/ 5 ft	2	1	1/26/1999 10:34	-0.047	0.0	0.0	0.0	0.0	7,640		
86-06/ 5 ft	2	1	2/23/1999 11:38	0.005	1.5	0.0	0.0	0.0	10,500		
86-06/ 5 ft	2	1	3/22/1999 10:36	0.012	1.9	0.0	0.0	0.0	9,430		
86-06/ 5 ft	2	1	7/30/1999	--	--	--	--	--	--	Pump failure	
86-06/ 5 ft	2	1	9/14/1999 11:31	0.012	0.0	0.0	0.0	1.3	10,600		0.0
86-06/ 5 ft	2	1	9/28/1999 11:28	0.007	0.0	0.0	0.0	0.0	8,180		
86-07R/ 5 ft	2	1	11/5/1998	--	--	--	--	--	--	Destroyed; substitute 86-06	
94-02/ 5 ft	2	1	7/30/1999 8:32	0.010	1.4	1.1	0.0	0.0	16,100		
94-02/ 5 ft	2	1	9/14/1999 10:37	0.007	0.0	0.0	0.0	1.8	10,000		0.0
94-02/ 5 ft	2	1	9/28/1999 10:31	0.002	0.0	0.0	0.0	0.0	8,480		
94-02/ 5 ft	2	1	3/22/1999	--	--	--	--	--	--	Unable to locate SGP 94-02 (construction)	
95-11/ 5 ft	2	1	11/5/1998 10:48	0.002	0.0	0.0	0.0	0.0	12,900		
95-11/ 5 ft	2	1	12/1/1998 10:07	0.002	0.0	0.0	0.0	0.0	7,870		
95-11/ 5 ft	2	1	12/31/1998 9:29	-0.035	1.5	0.0	0.0	0.0	8,890		
95-11/ 5 ft	2	1	1/26/1999 9:53	-0.012	2.5	0.0	0.0	0.0	6,680		
95-11/ 5 ft	2	1	2/23/1999	0.000	--	--	--	--	--	Unable to pull sample from SGP 95-11	
95-11/ 5 ft	2	1	3/22/1999	--	--	--	--	--	--	Unable to pull sample from SGP 95-11; tubing full of dirt	

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
95-12/ 5 ft	2	1	11/5/1998 10:38	0.000	1.2	1.1	0.0	0.0	13,700		
95-12/ 5 ft	2	1	12/1/1998 9:47	0.000	0.0	0.0	0.0	0.0	8,260		
95-12/ 5 ft	2	1	12/31/1998 9:14	-0.037	1.2	0.0	0.0	0.0	8,760		
95-12/ 5 ft	2	1	1/26/1999 9:37	-0.012	1.3	0.0	0.0	0.0	6,580		
95-12/ 5 ft	2	1	2/23/1999 10:17	-0.002	1.2	0.0	0.0	0.0	8,400		
95-12/ 5 ft	2	1	3/22/1999	--	--	--	--	--	--	SGP 95-12 destroyed	
95-14/ 5 ft	2	1	7/30/1999	--	--	--	--	--	--	Pump failure	
95-14/ 5 ft	2	1	9/14/1999	--	--	--	--	--	--	Unable to locate sample point	
CPT-16/ 10 ft	3	2	11/5/1998 11:34	0.000	1.5	0.0	0.0	0.0	13,000		
CPT-16/ 10 ft	3	2	12/1/1998 10:59	0.000	0.0	0.0	0.0	0.0	8,500		
CPT-16/ 10 ft	3	2	12/31/1998 10:21	-0.007	0.0	0.0	0.0	0.0	10,300		
CPT-16/ 10 ft	3	2	1/26/1999 10:40	-0.022	0.0	0.0	0.0	0.0	7,880		
CPT-16/ 10 ft	3	2	2/23/1999 11:43	-0.002	1.0	0.0	0.0	0.0	9,590		
CPT-16/ 10 ft	3	2	3/22/1999 11:17	0.017	0.0	0.0	0.0	0.0	11,600		
CPT-16/ 10 ft	3	2	7/30/1999	--	--	--	--	--	--	Pump failure	
CPT-16/ 10 ft	3	2	9/14/1999 12:09	0.025	0.0	0.0	1.0	1.0	12400		0.1
CPT-16/ 10 ft	3	2	9/28/1999 11:57	0.007	0.0	0.0	0.0	0.0	12,400		
CPT-17/ 10 ft	3	2	11/5/1998 10:31	0.000	3.2	0.0	0.0	0.0	13,000		
CPT-17/ 10 ft	3	2	12/1/1998 9:41	-0.005	1.7	0.0	0.0	0.0	8,110		
CPT-17/ 10 ft	3	2	12/31/1998 9:10	0.000	3.2	0.0	0.0	0.0	8,770		
CPT-17/ 10 ft	3	2	1/26/1999 9:33	-0.012	3.7	0.0	0.0	0.0	6,510		
CPT-17/ 10 ft	3	2	2/23/1999 10:13	-0.007	3.4	0.0	0.0	0.0	8,550		
CPT-17/ 10 ft	3	2	3/23/1999 10:28	0.007	5.1	0.0	0.0	0.0	13,700		
CPT-17/ 10 ft	3	2	7/30/1999 8:08	0.002	2.1	0.0	0.0	0.0	16,900		
CPT-17/ 10 ft	3	2	9/14/1999 9:35	0.007	2.6	0.0	0.0	1.7	9,550		0.2
CPT-17/ 10 ft	3	2	9/28/1999 9:22	-0.002	2.3	0.0	0.0	1.1	6,560		

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
CPT-18/ 15 ft	5	2	11/5/1998 10:44	0.000	0.0	0.0	0.0	0.0	13,300		
CPT-18/ 15 ft	5	2	12/1/1998 10:03	0.000	0.0	0.0	0.0	0.0	8,080		
CPT-18/ 15 ft	5	2	12/31/1998 9:25	0.002	5.0	0.0	0.0	0.0	8,910		
CPT-18/ 15 ft	5	2	1/26/1999 9:48	-0.020	4.5	0.0	0.0	0.0	6,560		
CPT-18/ 15 ft	5	2	2/23/1999 10:29	-0.007	4.6	0.0	0.0	0.0	8,400		
CPT-18/ 15 ft	5	2	3/23/1999 9:23	0.002	3.3	0.0	0.0	0.0	10,100		
CPT-18/ 15 ft	5	2	7/30/1999 8:23	0.005	1.3	0.0	0.0	0.0	16,900		
CPT-18/ 15 ft	5	2	9/14/1999 9:53	0.007	3.5	0.0	0.0	2.7	9,210		0.0
CPT-18/ 15 ft	5	2	9/14/1999 9:53	0.000	3.4	0.0	0.0	3.3	9,140	Duplicate	0.0
CPT-18/ 15 ft	5	2	9/28/1999 9:52	0.000	0.0	0.0	0.0	1.1	6,890		
CPT-21A/ 45 ft	14	2	7/30/1999 7:51	-0.027	51.7	1.2	0.0	0.0	14,900		
CPT-21A/ 45 ft	14	2	9/14/1999 9:24	-0.007	56.6	0.0	0.0	3.0	8,770		0.0
CPT-21A/ 45 ft	14	2	9/28/1999 9:12	-0.045	42.0	0.0	0.0	1.7	6,120		
W15-220SST/ 52 ft	16	2	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-220SST/ 52 ft	16	2	9/14/1999 11:51	0.045	1.6	0.0	0.0	1.5	10,100		0.0
W15-220SST/ 52 ft	16	2	9/28/1999 11:34	0.032	1.3	0.0	0.0	0.0	9,790		
CPT-28/ 60 ft	18	2	7/30/1999 7:30	-0.057	3.7	0.0	0.0	0.0	13,600		
CPT-28/ 60 ft	18	2	9/14/1999 9:12	-0.002	2.1	0.0	0.0	0.0	8,673		0.0
CPT-28/ 60 ft	18	2	9/28/1999 8:59	0.012	1.8	0.0	0.0	0.0	5,920		
CPT-9A/ 60 ft	18	2	7/30/1999	--	--	--	--	--	--	Pump failure	
CPT-9A/ 60 ft	18	2	9/14/1999 12:28	0.070	43.9	0.0	1.1	4.6	15,000		0.0
CPT-9A/ 60 ft	18	2	9/28/1999 12:03	0.037	44.0	0.0	0.0	3.0	14,400		
CPT-24/ 70 ft	21	2	7/30/1999	--	--	--	--	--	--	Pump failure	
CPT-24/ 70 ft	21	2	9/14/1999 10:45	0.030	3.6	0.0	1.3	7.0	9,350		0.0
CPT-24/ 70 ft	21	2	9/28/1999 10:44	-0.030	2.3	0.0	0.0	5.0	8,140		
W15-219SST/ 70 ft	21	2	7/30/1999	--	--	--	--	--	--	Pump failure	

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
W15-219SST/ 70 ft	21	2	9/14/1999 10:05	0.030	7.6	0.0	1.0	11.2	8,763		0.0
W15-219SST/ 70 ft	21	2	9/28/1999 10:08	-0.035	2.8	0.0	0.0	10.0	6,540		
W15-82/ 82 ft	25	2	11/5/1998 11:14	0.037	46.4	1.7	2.7	62.6	13,100		
W15-82/ 82 ft	25	2	11/5/1998 11:14	0.037	46.3	1.5	2.8	62.6	13,300	Duplicate	
W15-82/ 82 ft	25	2	12/1/1998 10:45	-0.082	19.2	0.0	2.8	58.0	8,420		
W15-82/ 82 ft	25	2	12/31/1998 10:08	-0.007	23.1	0.0	2.5	58.5	10,400		
W15-82/ 82 ft	25	2	1/26/1999 10:28	-0.249	22.1	0.0	1.4	32.0	7,840	Opened for vertical velocity profiling 1/6-1/19	
W15-82/ 82 ft	25	2	1/26/1999 10:28	-0.249	22.0	0.0	1.4	32.8	7,790	Duplicate; opened for vertical velocity profiling 1/6-1/19	
W15-82/ 82 ft	25	2	2/23/1999 11:32	-0.055	24.6	0.0	1.6	37.1	10,900		
W15-82/ 82 ft	25	2	3/22/1999 10:43	0.125	18.5	1.1	1.3	32.1	10,800		
W15-82/ 82 ft	25	2	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-82/ 82 ft	25	2	9/14/1999 11:21	0.077	42.5	2.9	2.0	31.2	9,680		0.0
W15-82/ 82 ft	25	2	9/28/1999 11:25	-0.015	38.1	2.3	1.5	27.0	10,500		
W15-95/ 82 ft	25	2	11/5/1998 11:05	0.040	39.4	0.0	0.0	1.2	13,200		
W15-95/ 82 ft	25	2	12/1/1998 10:37	-0.125	25.4	0.0	0.0	2.3	8,230		
W15-95/ 82 ft	25	2	12/31/1998 10:02	-0.339	37.3	0.0	0.0	2.5	9,950		
W15-95/ 82 ft	25	2	1/26/1999 10:22	-0.237	28.1	0.0	0.0	2.9	7,470		
W15-95/ 82 ft	25	2	2/23/1999 11:05	-0.052	30.6	0.0	0.0	2.9	10,100		
W15-95/ 82 ft	25	2	3/22/1999 11:11	-0.092	27.1	1.3	0.0	2.6	11,700		
W15-95/ 82 ft	25	2	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-95/ 82 ft	25	2	9/14/1999 11:14	-0.379	8.3	0.0	1.7	12.5	9,560		0.0
W15-95/ 82 ft	25	2	9/28/1999 11:18	-1.390	7.6	0.0	0.0	9.3	9,610		
CPT-21A/ 86 ft	26	2	11/5/1998 10:23	-0.015	126.0	1.8	0.0	0.0	13,200		
CPT-21A/ 86 ft	26	2	12/1/1998 9:32	-0.194	74.6	0.0	0.0	1.2	8,010		
CPT-21A/ 86 ft	26	2	12/31/1998 9:04	-0.042	140.0	1.1	0.0	1.6	8,690		

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
CPT-21A/ 86 ft	26	2	1/26/1999 9:27	-0.202	148.0	1.1	0.0	1.5	6,430		
CPT-21A/ 86 ft	26	2	2/23/1999 10:07	0.037	142.0	0.0	0.0	1.7	8,460		
CPT-21A/ 86 ft	26	2	3/23/1999 10:07	-0.102	119.0	1.1	0.0	1.0	12,600		
CPT-21A/ 86 ft	26	2	4/26/1999 11:43	-0.005	90.9	0.0	0.0	0.0	9,390		
CPT-21A/ 86 ft	26	2	5/25/1999 11:38	-0.120	61.9	0.0	0.0	0.0	22,700		
CPT-21A/ 86 ft	26	2	6/28/1999 10:17	-0.010	82.0	0.0	0.0	0.0	18,900		
CPT-21A/ 86 ft	26	2	7/30/1999 8:00	-0.070	66.6	0.0	0.0	0.0	15,500		
CPT-21A/ 86 ft	26	2	9/14/1999 9:28	-0.020	12.6	0.0	0.0	3.9	9,320		0.0
CPT-21A/ 86 ft	26	2	9/28/1999 9:16	-0.100	123.0	0.0	0.0	2.1	6,370		
W15-218SST/ 86 ft	26	2	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-218SST/ 86 ft	26	2	9/14/1999	0.194	--	--	--	--	--	Unable to pull sample due to low flow	
W15-218SST/ 86 ft	26	2	9/28/1999	0.050	--	--	--	--	--	Did not complete collection--low flow	
CPT-28/ 87 ft	27	2	11/5/1998 9:49	-0.002	184.0	2.7	0.0	0.0	13,200		
CPT-28/ 87 ft	27	2	12/1/1998 9:25	-0.194	65.2	0.0	0.0	1.3	7,940		
CPT-28/ 87 ft	27	2	12/31/1998 8:57	-0.030	203.0	1.5	0.0	2.0	8,720		
CPT-28/ 87 ft	27	2	1/26/1999 9:19	-0.202	170.0	1.2	0.0	1.3	6,380		
CPT-28/ 87 ft	27	2	2/23/1999 10:00	0.037	156.0	1.0	0.0	1.8	8,350		
CPT-28/ 87 ft	27	2	3/22/1999 10:08	0.095	176.0	2.0	0.0	0.0	9,630		
CPT-28/ 87 ft	27	2	4/26/1999 11:37	0.007	98.6	0.0	0.0	1.1	9,070		
CPT-28/ 87 ft	27	2	5/25/1999 11:31	-0.172	53.4	0.0	0.0	1.1	22,800		
CPT-28/ 87 ft	27	2	6/28/1999 10:04	-0.010	93.1	0.0	0.0	0.0	16,800		
CPT-28/ 87 ft	27	2	7/30/1999 7:37	-0.090	49.3	0.0	0.0	0.0	13,700		
CPT-28/ 87 ft	27	2	9/14/1999 9:16	-0.030	151.0	0.0	0.0	3.5	8,990		0.0
CPT-28/ 87 ft	27	2	9/28/1999 9:03	-0.107	105.0	0.0	0.0	2.1	5,900		
CPT-9A/ 91 ft	28	2	11/5/1998 11:42	0.015	39.0	0.0	0.0	0.0	12,800		

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
CPT-9A/ 91 ft	28	2	12/1/1998 11:06	-0.037	38.6	0.0	0.0	1.5	7,960		
CPT-9A/ 91 ft	28	2	12/31/1998 10:27	-0.012	12.4	0.0	0.0	0.0	11,300		
CPT-9A/ 91 ft	28	2	12/31/1998 10:27	-0.012	12.5	0.0	0.0	0.0	11,400	Duplicate	
CPT-9A/ 91 ft	28	2	1/26/1999 10:47	-0.100	39.8	0.0	0.0	1.1	8,220		
CPT-9A/ 91 ft	28	2	2/23/1999 11:50	0.037	32.2	0.0	0.0	0.0	9,670		
CPT-9A/ 91 ft	28	2	2/23/1999 11:50	0.037	32.5	0.0	0.0	1.1	9,710	Duplicate	
CPT-9A/ 91 ft	28	2	3/22/1999 11:44	0.107	37.7	0.0	0.0	0.0	11,800		
CPT-9A/ 91 ft	28	2	4/26/1999 12:34	0.020	37.5	0.0	0.0	1.0	7,430		
CPT-9A/ 91 ft	28	2	4/26/1999 12:34	0.020	37.5	0.0	0.0	0.0	7,430	Duplicate	
CPT-9A/ 91 ft	28	2	5/25/1999 11:44	-0.030	32.0	0.0	0.0	0.0	19,300		
CPT-9A/ 91 ft	28	2	6/28/1999 10:31	0.010	14.2	0.0	0.0	0.0	12,400		
CPT-9A/ 91 ft	28	2	7/30/1999	--	--	--	--	--	--	Pump failure	
CPT-9A/ 91 ft	28	2	9/14/1999 12:32	0.032	72.3	0.0	0.0	6.1	11,900		0.0
CPT-9A/ 91 ft	28	2	9/28/1999 12:07	0.012	17.3	0.0	0.0	0.0	9,170		
W15-217/ 115 ft	35	3	11/5/1998	--	--	--	--	--	--	Not in service	
W15-217/ 115 ft	35	3	12/1/1998 9:53	-0.207	26.8	0.0	0.0	0.0	8,200		
W15-217/ 115 ft	35	3	12/31/1998 9:20	-0.040	339.0	3.2	0.0	0.0	8,990		
W15-217/ 115 ft	35	3	1/26/1999 9:42	-0.187	348.0	3.2	0.0	1.0	6,810	Opened for vertical velocity profiling 1/6-1/19	
W15-217/ 115 ft	35	3	2/23/1999 10:22	0.047	418.0	3.5	0.0	1.4	9,030		
W15-217/ 115 ft	35	3	3/23/1999 8:45	-0.130	561.0	5.2	0.0	1.7	10,200		
W15-217/ 115 ft	35	3	7/30/1999 8:17	-0.120	68.6	1.2	0.0	4.8	13,700		
W15-217/ 115 ft	35	3	9/14/1999 9:46	-0.017	267.0	0.0	0.0	6.7	9,180		0.1
W15-217/ 115 ft	35	3	9/28/1999 9:42	-0.219	26.3	0.0	0.0	5.9	7,360		
CPT-24/ 118 ft	36	3	11/5/1998 10:57	0.000	37.1	2.1	0.0	0.0	13,100		
CPT-24/ 118 ft	36	3	12/1/1998 10:15	-0.271	37.3	1.3	0.0	1.5	8,070		
CPT-24/ 118 ft	36	3	12/31/1998 9:35	-0.042	33.5	0.0	0.0	0.0	9,210		

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
CPT-24/ 118 ft	36	3	1/26/1999 10:00	-0.319	20.9	0.0	0.0	0.0	6,810		
CPT-24/ 118 ft	36	3	2/23/1999 10:46	0.035	21.3	0.0	0.0	0.0	8,870		
CPT-24/ 118 ft	36	3	3/22/1999 11:33	0.222	25.6	1.3	0.0	0.0	12,100		
CPT-24/ 118 ft	36	3	7/30/1999	--	--	--	--	--	--	Pump failure	
CPT-24/ 118 ft	36	3	9/14/1999 10:51	0.017	33.3	0.0	1.1	4.3	9,740		0.0
CPT-24/ 118 ft	36	3	9/28/1999 10:50	-0.107	11.4	0.0	0.0	1.4	8,050		
W15-220SST/ 118 ft	36	4	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-220SST/ 118 ft	36	4	9/14/1999 11:57	0.209	35.9	0.0	0.0	2.7	10,200		0.0
W15-220SST/ 118 ft	36	4	9/28/1999 11:37	0.483	17.1	0.0	0.0	1.1	9,830		
W15-219SST/ 130 ft	40	4	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-219SST/ 130 ft	40	4	9/14/1999 10:16	0.142	46.5	0.0	0.0	7.3	8,600		0.0
W15-219SST/ 130 ft	40	4	9/28/1999	-0.386	--	--	--	--	--	Did not complete collection--low flow	
W15-219SST/ 155 ft	47	5	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-219SST/ 155 ft	47	5	9/14/1999 10:23	0.144	24.2	0.0	0.0	7.2	9,050		0.0
W15-219SST/ 155 ft	47	5	9/28/1999	-0.553	--	--	--	--	--	Did not complete collection--low flow	
W15-220SST/ 185 ft	56	5	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-220SST/ 185 ft	56	5	9/14/1999 12:01	0.207	13.4	0.0	0.0	2.9	9,770		0.0
W15-220SST/ 185 ft	56	5	9/28/1999 11:42	-0.471	8.4	0.0	0.0	2.4	9,940		
W15-220SST/ 185 ft	56	5	9/28/1999 11:42	-0.471	8.3	0.0	0.0	1.8	9,900	Duplicate	
W15-6L/ 189 ft	58	6	11/5/1998	--	--	--	--	--	--	Not in service	
W15-6L/ 189 ft	58	6	12/1/1998 10:22	-0.471	0.0	1.2	0.0	0.0	8,160		
W15-6L/ 189 ft	58	6	12/31/1998 9:47	0.311	1.3	0.0	0.0	0.0	10,100		
W15-6L/ 189 ft	58	6	1/26/1999 10:07	-0.007	1.1	0.0	0.0	0.0	7,260		
W15-6L/ 189 ft	58	6	2/23/1999 10:52	0.080	1.2	1.2	0.0	0.0	9,500		

Table E-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1998 Through September 1999. (9 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment	CO2 (%)
W15-6L/ 189 ft	58	6	3/22/1999 11:22	0.002	0.0	2.0	0.0	0.0	11,800	W15-6L tubing separated at first splice (~50 ft tubing in well), impossible to determine time of separation	
W15-9L/ 189 ft	58	6	11/5/1998	--	--	--	--	--	--	Not in service	
W15-9L/ 189 ft	58	6	12/1/1998 10:30	-0.448	14.6	0.0	0.0	1.3	8,120		
W15-9L/ 189 ft	58	6	12/1/1998 10:30	-0.448	14.5	0.0	0.0	1.1	8,170	Duplicate	
W15-9L/ 189 ft	58	6	12/31/1998 9:55	-0.042	14.9	0.0	0.0	1.5	9,940		
W15-9L/ 189 ft	58	6	1/26/1999 10:15	-0.162	14.1	0.0	0.0	1.3	7,360		
W15-9L/ 189 ft	58	6	2/23/1999 10:58	0.060	14.9	0.0	0.0	1.4	9,210		
W15-9L/ 189 ft	58	6	3/22/1999 11:06	-0.035	0.0	1.3	0.0	0.0	11,600	W15-9L tubing inadvertently cut and dropped down well	
W15-9L/ 189 ft	58	6	7/30/1999	--	--	--	--	--	--	Pump failure	
W15-9L/ 189 ft	58	6	9/14/1999 11:06	0.080	10.3	0.0	1.0	3.4	9,930		0.0
W15-9L/ 189 ft	58	6	9/28/1999 11:08	-0.075	1.1	0.0	0.0	1.0	6,340		

-- = no data

bgs = below ground surface

CCl4 = carbon tetrachloride

CH2Cl2 = methylene chloride

CHCl3 = chloroform

CO2 = carbon dioxide

MEK = methylethyl ketone

ppmv = parts per million by volume

**Table E-3. Carbon Tetrachloride Concentration Standard Analyses,
October 1998 Through September 1999.**

Carbon Tetrachloride Concentration Standard (ppmv)	Carbon Tetrachloride Concentration Analyzed (ppmv)	Date Analyzed	Time Analyzed	B&K Serial Number
25.5	25.1	01/26/99	11:04	1715232
25.5	25.5	01/26/99	12:08	1715232
25.5	25.1	02/23/99	12:26	1715232
25.5	25.6	02/23/99	13:26	1715232
25.5	23.9	03/22/99	12:17	1715232
25.5	25.2	03/23/99	10:46	1715232
25.5	24.9	03/22/99	13:07	1715232
25.5	28.7	03/23/99	10:56	1715232
25.5	25.4	04/26/99	12:52	1715232
25.5	26.8	04/26/99	13:52	1715232
25.5	25.5	05/25/99	11:56	1715232
25.5	26.6	05/25/99	12:54	1715232
25.5	25.6	06/28/99	10:43	1715232
25.5	26.6	06/28/99	11:41	1715232
25.5	25.2	07/30/99	9:55	1715232
25.5	25.7	07/30/99	10:17	1715232
25.5	26.4	09/14/99	13:24	1747619
25.5	26.7	09/14/99	14:17	1747619
25.5	26.1	09/28/99	12:32	1747619
25.5	26.7	09/28/99	13:32	1747619
25.5	23.9	11/05/98	12:05	1715232
25.5	24.9	11/05/98	12:57	1715232
25.5	25.1	12/01/98	12:39	1715232
25.5	25.3	12/01/98	13:41	1715232
25.5	25.1	12/31/98	10:42	1715232
25.5	25.4	12/31/98	11:42	1715232

Table E-4. Blank Analyses^a, October 1998 Through September 1999.

Sample Location	Sample Date	Sample Time	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)
Blank	11/05/98	12:03	0.00	1.09	0.00	0.00	10,400
Blank	11/05/98	12:59	0.00	0.00	0.00	0.00	12,900
Blank	12/01/98	12:37	0.00	0.00	0.00	0.00	7,930
Blank	12/01/98	13:43	0.00	0.00	0.00	0.00	9,430
Blank	12/31/98	10:42	0.00	0.00	0.00	0.00	7,960
Blank	12/31/98	11:44	0.00	0.00	0.00	0.00	8,890
Blank	01/26/99	11:02	0.00	3.93	0.00	0.00	5,800
Blank	01/26/99	11:06	0.00	0.00	0.00	0.00	5,710
Blank	01/26/99	12:10	0.00	0.00	0.00	0.00	7,420
Blank	02/23/99	12:24	0.00	0.00	0.00	0.00	7,730
Blank	02/23/99	13:28	0.00	0.00	0.00	0.00	8,290
Blank	03/22/99	12:15	0.00	0.00	0.00	0.00	7,830
Blank	03/22/99	13:09	0.00	0.00	0.00	0.00	9,430
Blank	03/23/99	10:44	0.00	0.00	0.00	0.00	7,810
Blank	03/23/99	10:58	0.00	0.00	0.00	0.00	8,950
Blank	04/26/99	12:50	0.00	0.00	0.00	0.00	4,500
Blank	04/26/99	13:54	0.00	0.00	0.00	0.00	5,810
Blank	05/25/99	11:54	0.00	0.00	0.00	0.00	8,250
Blank	05/25/99	12:56	0.00	0.00	0.00	0.00	8,080
Blank	06/28/99	10:41	0.00	0.00	0.00	0.00	9,580
Blank	06/28/99	11:43	0.00	0.00	0.00	0.00	8,830
Blank	07/30/99	9:53	0.00	0.00	0.00	0.00	9,770
Blank	07/30/99	10:19	0.00	0.00	0.00	0.00	8,820
Blank	09/14/99	13:22	0.00	0.00	0.00	0.00	9,370
Blank	09/14/99	14:19	0.00	0.00	0.00	0.00	13,500
Blank	09/28/99	12:30	0.00	0.00	0.00	0.00	6,330
Blank	09/28/99	13:34	0.00	0.00	0.00	0.00	6,440

^a Analyses of the vapor headspace in blank samples of deionized water.

CCl4 = carbon tetrachloride

CHCl3 = chloroform

MEK = methylethyl ketone

CH2Cl2 = methylene chloride

APPENDIX F

FISCAL YEAR 2000 SOIL VAPOR MONITORING DATA

**Table F-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield
During Nonoperation of the SVE System, October 1999 Through September 2000. (4 Pages)**

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-32/ 25 ft	7.6	2	10/26/99 7:47	-0.030	0.00	0.00	0.00	0.00	8,330	
CPT-32/ 25 ft	7.6	2	11/30/99 10:36	0.020	0.00	0.00	0.00	1.34	9,030	
CPT-32/ 25 ft	7.6	2	12/29/99 9:00	-0.020	1.49	0.00	0.00	0.00	6,520	
CPT-32/ 25 ft	7.6	2	1/25/00 8:04	--	3.82	0.00	0.00	0.00	7,910	Differential pressure transducer not functional.
CPT-32/ 25 ft	7.6	2	3/7/00 8:56	--	9.36	0.00	0.00	1.15	7,350	Differential pressure transducer not functional.
CPT-32/ 25 ft	7.6	2	6/2/00 8:45	0.000	8.58	0.00	0.00	1.63	11,200	
CPT-32/ 25 ft	7.6	2	6/27/00 8:23	0.000	7.22	0.00	0.00	2.02	10,300	
CPT-32/ 25 ft	7.6	2	7/24/00 8:57	0.030	8.08	0.00	0.00	1.43	10,200	
CPT-32/ 25 ft	7.6	2	8/29/00 8:04	-0.020	6.64	0.00	0.00	1.36	10,000	
CPT-32/ 25 ft	7.6	2	9/25/00 8:29	-0.010	6.43	0.00	0.00	0.00	7,370	
CPT-30/ 28 ft	8.5	2	10/26/99 7:40	-0.020	0.00	0.00	0.00	0.00	8,010	
CPT-30/ 28 ft	8.5	2	11/30/99 10:00	-0.060	1.00	0.00	0.00	2.48	8,540	
CPT-30/ 28 ft	8.5	2	12/29/99 8:55	-0.020	1.42	0.00	0.00	1.18	6,500	
CPT-30/ 28 ft	8.5	2	1/25/00 7:59	--	0.00	0.00	0.00	0.00	7,920	Differential pressure transducer not functional.
CPT-30/ 28 ft	8.5	2	3/7/00 8:53	--	0.00	0.00	0.00	0.00	7,620	Differential pressure transducer not functional.
CPT-30/ 28 ft	8.5	2	6/2/00 8:14	0.000	0.00	0.00	0.00	1.45	9,890	
CPT-30/ 28 ft	8.5	2	6/27/00 8:15	0.000	0.00	0.00	0.00	1.89	10,600	
CPT-30/ 28 ft	8.5	2	7/24/00 9:02	0.020	0.00	0.00	0.00	1.24	10,500	
CPT-30/ 28 ft	8.5	2	8/29/00 8:00	-0.040	0.00	0.00	0.00	1.38	9,880	
CPT-30/ 28 ft	8.5	2	9/25/00 8:34	-0.030	1.04	0.00	0.00	0.00	7,390	
CPT-13A/ 30 ft	9.1	2	10/26/99 8:07	-0.010	0.00	0.00	0.00	0.00	8,660	
CPT-13A/ 30 ft	9.1	2	11/30/99 12:08	0.100	0.00	0.00	0.00	0.00	11,100	
CPT-13A/ 30 ft	9.1	2	12/29/99 9:23	-0.030	1.64	0.00	0.00	0.00	7,130	
CPT-13A/ 30 ft	9.1	2	1/25/00 8:37	--	1.14	0.00	0.00	0.00	8,360	Differential pressure transducer not functional.
CPT-13A/ 30 ft	9.1	2	3/7/00 9:12	--	2.12	0.00	0.00	0.00	8,400	Differential pressure transducer not functional.
CPT-13A/ 30 ft	9.1	2	6/2/00 9:06	0.610	2.52	0.00	0.00	0.00	12,500	
CPT-13A/ 30ft	9.1	2	6/27/00 8:53	0.000	3.44	0.00	0.00	1.15	10,500	
CPT-13A/ 30 ft	9.1	2	6/27/00 8:53	0.000	3.26	0.00	0.00	0.00	10,400	Duplicate
CPT-13A/ 30 ft	9.1	2	7/24/00 9:18	0.060	2.46	0.00	0.00	1.10	10,400	

Table F-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (4 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-13A/ 30 ft	9.1	2	8/29/00 8:40	0.020	3.43	0.00	0.00	0.00	10,700	
CPT-13A/ 30 ft	9.1	2	9/25/00 9:00	-0.020	2.60	0.00	0.00	0.00	7,970	
CPT-7A/ 32 ft	9.8	2	10/26/99 8:37	-0.030	2.32	0.00	0.00	0.00	9,430	
CPT-7A/ 32 ft	9.8	2	11/30/99 12:15	-0.450	1.86	0.00	0.00	0.00	11,000	
CPT-7A/ 32 ft	9.8	2	12/29/99 9:31	-0.020	2.79	0.00	0.00	0.00	7,170	
CPT-7A/ 32 ft	9.8	2	1/25/00 8:42	--	2.25	0.00	0.00	0.00	8,490	Differential pressure transducer not functional.
CPT-7A/ 32 ft	9.8	2	3/7/00 9:24	--	4.39	0.00	0.00	0.00	9,030	Differential pressure transducer not functional.
CPT-7A/ 32 ft	9.8	2	6/2/00 10:21	0.030	4.74	0.00	0.00	0.00	16,400	
CPT-7A/ 32 ft	9.8	2	6/27/00 9:04	-0.010	6.15	0.00	0.00	1.72	11,300	
CPT-7A/ 32 ft	9.8	2	7/24/00 9:29	0.050	3.88	0.00	0.00	1.09	11,400	
CPT-7A/ 32 ft	9.8	2	8/29/00 9:00	0.040	4.30	0.00	0.00	1.20	10,900	
CPT-7A/ 32 ft	9.8	2	9/25/00 9:12	-0.030	3.89	0.00	0.00	0.00	8,910	
CPT-1A/ 35 ft	10.7	2	10/26/99 7:34	-0.040	2.47	0.00	0.00	0.00	7,490	
CPT-1A/ 35 ft	10.7	2	11/30/99 9:30	-0.070	3.07	0.00	0.00	1.87	8,710	
CPT-1A/ 35 ft	10.7	2	12/29/99 8:37	-0.010	2.80	0.00	0.00	1.88	6,610	
CPT-1A/ 35 ft	10.7	2	1/25/00 7:52	--	4.06	0.00	0.00	1.06	7,830	Differential pressure transducer not functional.
CPT-1A/ 35 ft	10.70	2	3/7/00 8:46	--	3.33	0.00	0.00	0.00	7,790	Differential pressure transducer not functional.
CPT-1A/ 35 ft	10.70	2	6/2/00 8:03	0.000	4.23	0.00	0.00	1.77	10,600	
CPT-1A/ 35 ft	10.7	2	6/27/00 8:06	-0.020	3.73	0.00	0.00	2.38	10,100	
CPT-1A/ 35 ft	10.7	2	7/24/00 8:39	0.010	3.72	0.00	0.00	1.53	9,770	
CPT-1A/ 35 ft	10.7	2	8/29/00 7:56	-0.070	4.26	0.00	0.00	1.87	9,910	
CPT-1A/ 35 ft	10.7	2	9/25/00 8:11	-0.020	4.04	0.00	0.00	1.26	6,980	
W18-152/ 113 ft	34.4	2	10/26/99 7:30	-0.280	1.81	0.00	0.00	1.72	8,030	
W18-152/ 113 ft	34.4	2	11/30/99 9:46	-0.390	22.10	0.00	0.00	2.23	9,060	
W18-152/ 113 ft	34.4	2	12/29/99 8:31	0.180	24.70	0.00	0.00	1.27	6,570	
W18-152/ 113 ft	34.4	2	12/29/99 8:31	0.180	25.60	0.00	0.00	1.45	6,740	Duplicate
W18-152/ 113 ft	34.4	2	1/25/00 7:48	--	17.70	0.00	0.00	1.78	7,850	Differential pressure transducer not functional.
W18-152/ 113 ft	34.4	2	3/7/00 8:20	--	3.70	0.00	0.00	0.00	7,140	Differential pressure transducer not functional.
W18-152/ 113 ft	34.4	2	6/2/00 7:56	0.090	22.90	0.00	0.00	2.23	10,100	
W18-152/ 113 ft	34.4	2	6/27/00 8:04	-0.180	3.13	0.00	1.01	2.25	10,400	

**Table F-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield
During Nonoperation of the SVE System, October 1999 Through September 2000. (4 Pages)**

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
W18-152/ 113 ft	34.4	2	7/24/00 8:16	-0.140	1.80	0.00	0.00	1.43	9,610	
W18-152/ 113 ft	34.4	2	8/29/00 7:51	0.080	13.70	0.00	0.00	2.15	9,760	
W18-152/ 113 ft	34.4	2	9/25/00 8:07	-0.100	5.20	0.00	0.00	1.34	7,310	
W18-158L 123 ft	37.5	3	8/29/00 8:10	0.060	151.00	0.00	7.52	174.00	10,000	
W18-158L 123 ft	37.5	3	9/25/00 8:18	-0.130	141.00	0.00	6.75	165.00	7,240	
W18-158L/ 123 ft	37.5	3	10/26/99 8:23	-0.330	79.60	0.00	4.18	138.00	8,680	
W18-158L/ 123 ft	37.5	3	11/30/99 11:23	0.050	103.00	0.00	3.90	145.00	9,780	B filter value used for CCl4; A filter = 83.7 ppmv.
W18-158L/ 123 ft	37.5	3	12/29/99 8:45	0.240	134.00	0.00	4.58	170.00	6,620	
W18-158L/ 123 ft	37.5	3	1/25/00 9:00	--	132.00	0.00	4.79	173.00	8,030	Differential pressure transducer not functional. B filter value used for CCl4; A filter = 97.5 ppmv.
W18-158L/ 123 ft	37.5	3	3/7/00 8:30	--	152.00	0.00	6.60	165.00	7,120	Differential pressure transducer not functional.
W18-158L/ 123 ft	37.5	3	6/2/00 8:23	0.000	134.00	0.00	3.49	85.20	19,000	
W18-158L/ 123 ft	37.5	3	6/27/00 8:29	-0.230	196.00	0.00	6.76	141.00	10,600	
W18-158L/ 123 ft	37.5	3	7/24/00 8:46	-0.240	186.00	0.00	7.26	165.00	10,200	
W18-158L/ 123 ft	37.5		7/24/00 8:46	--	179.00	0.00	7.27	167.00	10,200	Duplicate
W18-167/ 123 ft	37.5	3	10/26/99 8:26	-0.340	88.800	0.00	0.00	7.06	8,760	
W18-167/ 123 ft	37.5	3	11/30/99 11:31	0.090	115.00	0.00	0.00	1.78	10,400	Sample bag torn during second A filter reading - no data
W18-167/ 123 ft	37.5	3	12/29/99 8:48	0.220	144.00	0.00	0.00	4.29	6,690	
W18-167/ 123 ft	37.5	3	1/25/00 9:10	--	109.00	0.00	0.00	4.36	8,280	Differential pressure transducer not functional. B filter value used for CCl4; A filter = 104 ppmv.
W18-167/ 123 ft	37.5	3	3/7/00 8:36	--	104.00	0.00	0.00	6.64	6,840	Differential pressure transducer not functional. B filter value used for CCl4; A filter = 90 ppmv.
W18-167/ 123 ft	37.5	3	6/2/00 8:27	0.000	248.00	2.55	0.00	3.30	19,600	
W18-167/ 123 ft	37.5	3	6/27/00 8:34	-0.030	227.00	2.02	1.16	6.31	11,400	
W18-167/ 123 ft	37.5	3	7/24/00 8:50	-0.200	216.00	1.35	1.10	8.78	10,600	
W18-167/ 123 ft	37.5	3	8/29/00 8:14	0.040	167.00	0.00	0.00	7.16	9,990	

Table F-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (4 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
W18-167/ 123 ft	37.5	3	9/25/00 8:22	-0.120	174.00	0.00	0.00	7.23	7,300	
W18-249/ 134 ft	40.8	3	10/26/99 7:56	-0.380	74.80	0.00	0.00	1.93	8,280	
W18-249/ 134 ft	40.8	3	11/30/99 10:18	-0.360	132.00	0.00	0.00	0.00	9,070	B filter value used for CCl4; A filter = 120 ppmv.
W18-249/ 134 ft	40.8	3	12/29/99 9:06	0.230	173.00	0.00	0.00	0.00	6,720	B filter value used for CCl4; A filter = 163 ppmv.
W18-249/ 134 ft	40.8	3	1/25/00 8:15	--	149.00	0.00	0.00	0.00	7,870	Differential pressure transducer not functional. B filter value used for CCl4; A filter = 131 ppmv.
W18-249/ 134 ft	40.8	3	3/7/00 9:05	--	60.00	0.00	0.00	1.30	7,690	Differential pressure transducer not functional.
W18-249/ 134 ft	40.8	3	6/2/00 8:59	0.160	176.00	2.20	0.00	1.76	21,700	
W18-249/ 134 ft	40.8	3	6/27/00 8:43	-0.230	137.00	0.00	1.29	3.64	10,500	
W18-249/ 134 ft	40.8	3	7/24/00 9:11	-0.170	78.30	0.00	0.00	2.48	10,300	
W18-249/ 134 ft	40.8	3	8/29/00 8:54	0.130	154.00	0.00	0.00	2.48	10,400	
W18-249/ 134 ft	40.8	3	9/25/00 8:40	-0.150	95.20	0.00	0.00	2.30	7,760	
W18-248/ 136 ft	41.5	3	10/26/99 8:13	-0.440	130.00	0.00	0.00	5.09	8,370	
W18-248/ 136 ft	41.5	3	11/30/99 12:21	0.300	96.70	0.00	0.00	2.21	11,400	
W18-248/ 136 ft	41.5	3	12/29/99 9:27	0.600	85.50	0.00	0.00	2.34	7,070	
W18-248/ 136 ft	41.5	3	1/25/00 9:26	--	110.00	0.00	0.00	1.99	8,310	Differential pressure transducer not functional. B filter value used for CCl4; A filter = 106 ppmv.
W18-248/ 136 ft	41.5	3	3/7/00 9:17	--	130.00	0.00	0.00	3.85	7,610	Differential pressure transducer not functional. B filter value used for CCl4; A filter = 129 ppmv.
W18-248/ 136 ft	41.5	3	6/2/00 10:14	0.420	183.00	1.67	0.00	4.68	12,600	
W18-248/ 136 ft	41.5	3	6/27/00 8:57	-0.440	186.00	0.00	1.11	6.23	11,400	
W18-248/ 136 ft	41.5	3	7/24/00 9:23	-0.230	170.00	0.00	1.02	4.77	10,300	

Table F-1. Carbon Tetrachloride Concentrations Monitored at the 216-Z-1A/Z-18/Z-12 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (4 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl ₄ (ppmv)	CHCl ₃ (ppmv)	MEK (ppmv)	CH ₂ Cl ₂ (ppmv)	Water (ppmv)	Comment
W18-248/ 136 ft	41.5	3	8/29/00 8:45	0.260	184.00	0.00	0.00	3.65	10,600	
W18-248/ 136 ft	41.5	3	9/25/00 9:07	-0.180	202.00	0.00	0.00	4.04	8,250	

-- = no data

bgs = below ground surface

CCl₄ = carbon tetrachlorideCH₂Cl₂ = methylene chlorideCHCl₃ = chloroform

MEK = methylethyl ketone

ppmv = parts per million by volume

Table F-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (5 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-17/ 10 ft	3.0	2	10/26/99 9:10	-0.030	1.71	0.00	0.00	1.18	9,880	
CPT-17/ 10 ft	3.0	2	11/30/99 12:40	-0.210	3.10	0.00	0.00	2.19	11,400	
CPT-17/ 10 ft	3.0	2	1/25/00 10:09	--	2.91	0.00	0.00	2.07	9,640	Differential pressure transducer not functional.
CPT-17/ 10 ft	3.0	2	3/7/00 10:02	--	1.65	0.00	0.00	0.00	10,300	Differential pressure transducer not functional.
CPT-17/ 10 ft	3.0	2	6/2/00 10:40	-0.010	5.09	0.00	0.00	1.91	13,900	
CPT-17/ 10 ft	3.0	2	7/24/00 10:05	0.030	4.17	0.00	0.00	1.54	11,500	
CPT-17/ 10 ft	3.0	2	8/29/00 9:20	0.030	4.56	0.00	0.00	1.08	12,500	
CPT-17/ 10 ft	3.0	2	9/25/00 9:45	-0.010	4.41	0.00	0.00	0.00	10,200	
CPT-17/ 10 ft	3.0	2	6/27/00 9:25	0.050	3.44	0.00	0.00	2.32	10,500	
CPT-17/ 10ft	3.0	2	12/29/99 9:54	-0.010	2.56	0.00	0.00	1.48	6,820	
CPT-18/ 15 ft	4.6	2	10/26/99 9:25	-0.020	1.83	0.00	0.00	1.80	10,000	
CPT-18/ 15 ft	4.6	2	11/30/99 12:49	-0.010	1.63	0.00	0.00	1.84	11,100	
CPT-18/ 15 ft	4.6	2	11/30/99 12:49	-0.010	1.50	0.00	0.00	2.05	10,900	Duplicate
CPT-18/ 15 ft	4.6	2	1/25/00 10:36	--	2.78	0.00	0.00	0.00	10,800	Differential pressure transducer not functional.
CPT-18/ 15 ft	4.6	2	3/7/00 10:11	--	2.56	0.00	0.00	1.61	10,600	Differential pressure transducer not functional.
CPT-18/ 15 ft	4.6	2	6/2/00 10:50	0.020	5.22	0.00	0.00	1.59	13,200	
CPT-18/ 15 ft	4.6	2	6/27/00 9:55	0.120	3.80	0.00	0.00	1.96	13,900	
CPT-18/ 15 ft	4.6	2	7/24/00 10:13	0.040	1.99	0.00	0.00	1.53	11,700	
CPT-18/ 15 ft	4.6	2	8/29/00 9:42	0.040	4.13	0.00	0.00	1.22	11,600	
CPT-18/ 15 ft	4.6	2	9/25/00 9:54	0.000	3.15	0.00	0.00	0.00	9,960	
CPT-18/ 15ft	4.6	2	12/29/99 10:17	-0.010	4.33	0.00	0.00	1.97	7,870	
CPT-16/ 25 ft	7.6	2	10/26/99 10:01	-0.040	0.00	0.00	0.00	0.00	10,500	
CPT-16/ 25 ft	7.6	2	11/30/99 13:22	-0.020	0.00	0.00	0.00	0.00	11,900	
CPT-16/ 25 ft	7.6	2	12/29/99 10:48	0.000	0.00	0.00	0.00	0.00	7,810	
CPT-16/ 25 ft	7.6	2	1/25/00 10:56	--	0.00	0.00	0.00	0.00	9,930	Differential pressure transducer not functional.
CPT-16/ 25 ft	7.6	2	3/7/00 10:41	--	0.00	0.00	0.00	0.00	15,400	Differential pressure transducer not functional.
CPT-16/ 25 ft	7.6	2	6/2/00 11:20	0.060	0.00	0.00	0.00	0.00	12,500	
CPT-16/ 25 ft	7.6	2	6/27/00 10:17	0.070	1.55	0.00	0.00	0.00	11,400	
CPT-16/ 25 ft	7.6	2	7/24/00 10:34	0.050	1.35	0.00	0.00	0.00	11,800	

Table F-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (5 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-16/ 25 ft	7.6	2	8/29/00 10:36	0.070	1.77	0.00	0.00	0.00	12,200	
CPT-16/ 25 ft	7.6	2	9/25/00 10:21	0.000	1.74	0.00	0.00	0.00	11,700	
CPT-27/ 33 ft	10.1	2	10/26/99 9:56	-0.060	1.08	0.00	0.00	0.00	10,600	
CPT-27/ 33 ft	10.1	2	11/30/99 13:17	0.000	0.00	0.00	0.00	0.00	11,700	
CPT-27/ 33 ft	10.1	2	12/29/99 10:39	-0.030	1.20	0.00	0.00	0.00	7,020	
CPT-27/ 33 ft	10.1	2	1/25/00 10:52	--	1.20	0.00	0.00	1.03	10,100	Differential pressure transducer not functional.
CPT-27/ 33 ft	10.1	2	3/7/00 10:36	--	1.25	0.00	0.00	1.15	14,400	Differential pressure transducer not functional.
CPT-27/ 33 ft	10.1	2	6/2/00 11:13	0.020	1.55	0.00	0.00	1.20	12,500	
CPT-27/ 33 ft	10.1	2	6/27/00 10:13	0.060	1.34	0.00	0.00	1.45	12,300	
CPT-27/ 33 ft	10.1	2	7/24/00 10:30	0.060	1.21	0.00	0.00	0.00	12,600	
CPT-27/ 33 ft	10.1	2	8/29/00 10:27	0.070	1.76	0.00	0.00	0.00	12,800	
CPT-27/ 33 ft	10.1	2	9/25/00 10:12	0.010	1.62	0.00	0.00	0.00	11,800	
CPT-21A/ 45 ft	13.7	2	10/26/99 8:47	-0.170	50.30	0.00	0.00	1.42	9,420	
CPT-21A/ 45 ft	13.7	2	11/30/99 12:33	0.020	78.00	0.00	0.00	2.59	11,000	
CPT-21A/ 45 ft	13.7	2	12/29/99 9:47	-0.060	70.40	0.00	0.00	2.46	7,050	
CPT-21A/ 45 ft	13.7	2	1/25/00 9:50	--	81.60	0.00	0.00	1.88	9,270	Differential pressure transducer not functional.
CPT-21A/ 45 ft	13.7	2	3/7/00 9:45	--	54.00	0.00	0.00	2.78	10,000	Differential pressure transducer not functional.
CPT-21A/ 45 ft	13.7	2	6/2/00 10:33	0.100	94.00	0.00	0.00	4.84	13,600	
CPT-21A/ 45 ft	13.7	2	6/27/00 9:16	-0.180	88.70	0.00	1.11	5.58	11,200	
CPT-21A/ 45 ft	13.7	2	7/24/00 9:49	0.010	91.40	0.00	0.00	4.57	11,800	
CPT-21A/ 45 ft	13.7	2	8/29/00 9:08	0.170	122.00	0.00	0.00	4.88	11,400	
CPT-21A/ 45 ft	13.7	2	9/25/00 9:34	-0.100	96.40	0.00	0.00	4.05	9,990	
CPT-9A/ 60 ft	18.3	2	10/26/99 10:06	-0.150	32.90	0.00	0.00	2.69	11,000	
CPT-9A/ 60 ft	18.3	2	11/30/99 13:28	-0.050	39.30	0.00	0.00	3.61	12,200	
CPT-9A/ 60 ft	18.3	2	12/29/99 10:56	0.040	43.50	0.00	0.00	3.29	8,130	
CPT-9A/ 60 ft	18.3	2	1/25/00 11:00	--	38.10	0.00	0.00	2.71	9,830	Differential pressure transducer not functional.
CPT-9A/ 60 ft	18.3	2	3/7/00 10:47	--	33.20	0.00	0.00	2.48	14,300	Differential pressure transducer not functional.
CPT-9A/ 60 ft	18.3	2	6/2/00 11:25	0.140	43.90	0.00	0.00	3.75	15,400	
CPT-9A/ 60 ft	18.3	2	7/24/00 10:43	0.140	40.30	0.00	0.00	3.41	12,300	
CPT-9A/ 60 ft	18.3	2	8/29/00 10:45	0.220	41.60	0.00	0.00	3.59	15,100	

Table F-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (5 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-9A/ 60 ft	18.3	2	9/25/00 10:26	-0.020	42.20	0.00	0.00	2.98	11,500	
CPT-9A/ 60 ft	18.3	2	9/25/00 10:26	-0.020	42.50	0.00	0.00	3.00	11,600	Duplicate
CPT-9A/ 60ft	18.3	2	6/27/00 10:24	-0.080	67.60	0.00	1.02	5.68	12,600	
W15-82/ 82 ft	25.0	2	10/26/99 9:52	-0.540	35.70	2.59	1.21	29.30	10,100	
W15-82/ 82 ft	25.0	2	11/30/99 13:09	0.180	23.40	3.17	0.00	19.40	12,800	
W15-82/ 82 ft	25.0	2	12/29/99 10:35	0.240	21.20	3.24	0.00	23.90	8,030	
W15-82/ 82 ft	25.0	2	1/25/00 10:48	--	19.00	1.89	0.00	21.40	9,680	Differential pressure transducer not functional.
W15-82/ 82 ft	25.0	2	3/7/00 10:32	--	29.80	0.00	1.23	25.00	12,800	Differential pressure transducer not functional.
W15-82/ 82 ft	25.0	2	6/2/00 11:07	0.360	25.50	0.00	2.21	42.30	14,900	
W15-82/ 82 ft	25.0	2	6/27/00 10:10	-0.100	23.50	0.00	2.63	40.20	12,300	
W15-82/ 82 ft	25.0	2	7/24/00 10:27	0.040	25.50	0.00	2.21	45.60	11,200	
W15-82/ 82 ft	25.0	2	8/29/00 10:12	0.450	26.50	0.00	2.64	47.50	11,800	
W15-82/ 82 ft	25.0	2	8/29/00 10:12	0.450	26.50	0.00	2.65	48.00	11,700	Duplicate
W15-82/ 82 ft	25.0	2	9/25/00 10:16	-0.120	28.70	0.00	2.32	49.50	11,100	
W15-95/ 82 ft	25.0	2	10/26/99 9:47	-0.010	8.99	0.00	0.00	9.54	9,860	
W15-95/ 82 ft	25.0	2	11/30/99 13:02	-0.140	11.20	0.00	0.00	8.44	12,400	
W15-95/ 82 ft	25.0	2	12/29/99 10:31	-1.350	12.00	0.00	0.00	8.83	7,950	
W15-95/ 82 ft	25.0	2	1/25/00 10:45	--	14.50	0.00	0.00	9.04	9,810	Differential pressure transducer not functional.
W15-95/ 82 ft	25.0	2	1/25/00 10:45	--	14.40	0.00	0.00	9.00	9,680	Duplicate
W15-95/ 82 ft	25.0	2	3/7/00 10:26	--	13.20	0.00	0.00	7.09	10,900	Differential pressure transducer not functional.
W15-95/ 82 ft	25.0	2	3/7/00 10:26	--	13.10	0.00	0.00	7.37	10,900	Duplicate
W15-95/ 82 ft	25.0	2	6/2/00 11:02	-1.500	21.20	0.00	1.17	10.40	13,500	
W15-95/ 82 ft	25.0	2	6/27/00 10:05	0.200	21.70	0.00	1.28	9.54	12,000	
W15-95/ 82 ft	25.0	2	7/24/00 10:23	-0.490	23.70	0.00	1.55	9.71	12,500	
W15-95/ 82 ft	25.0	2	8/29/00 10:03	-1.830	27.40	0.00	1.19	9.16	13,000	
W15-95/ 82 ft	25.0	2	9/25/00 10:07	-0.380	28.50	0.00	0.00	8.97	11,100	
CPT-21A/ 86 ft	26.2	2	10/26/99 8:51	-0.350	90.70	0.00	0.00	2.10	9,520	
CPT-21A/ 86 ft	26.2	2	10/26/99 8:51	-0.350	91.10	0.00	0.00	2.01	9,520	Duplicate
CPT-21A/ 86 ft	26.2	2	11/30/99 12:35	-0.020	133.00	0.00	0.00	2.90	11,400	B filter value used for CC14; A filter = 126 ppmv.

Table F-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (5 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
CPT-21A/ 86 ft	26.2	2	12/29/99 9:51	0.000	123.00	0.00	0.00	2.12	7,030	B filter value used for CC14; A filter = 116 ppmv.
CPT-21A/ 86 ft	26.2	2	1/25/00 9:54	--	141.00	0.00	0.00	2.23	9,360	Differential pressure transducer not functional.
CPT-21A/ 86 ft	26.2	2	3/7/00 9:53	--	113.00	0.00	0.00	1.65	9,600	Differential pressure transducer not functional. B filter value used for CC14; A filter = 112 ppmv.
CPT-21A/ 86 ft	26.2	2	6/2/00 10:35	0.190	195.00	0.00	0.00	5.25	13,600	
CPT-21A/ 86 ft	26.2	2	6/27/00 9:19	-0.340	186.00	0.00	0.00	5.48	11,600	
CPT-21A/ 86 ft	26.2	2	7/24/00 9:52	-0.010	169.00	0.00	0.00	5.54	11,800	
CPT-21A/ 86 ft	26.2	2	8/29/00 9:11	0.250	189.00	0.00	0.00	5.72	11,600	
CPT-21A/ 86 ft	26.2	2	9/25/00 9:37	-0.170	175.00	0.00	0.00	4.61	10,200	
CPT-28/ 87 ft	26.5	2	10/26/99 8:43	-0.360	104.00	0.00	0.00	2.36	9,450	B filter value used for CC14; A filter = 89.5 ppmv.
CPT-28/ 87 ft	26.5	2	11/30/99 12:27	0.070	170.00	0.00	0.00	3.18	11,200	B filter value used for CC14; A filter = 151 ppmv.
CPT-28/ 87 ft	26.5	2	12/29/99 9:43	-0.510	180.00	0.00	0.00	2.62	7,210	B filter value used for CC14; A filter = 154 ppmv.
CPT-28/ 87 ft	26.5	2	1/25/00 9:42	--	181.00	0.00	0.00	1.94	9,110	Differential pressure transducer not functional. B filter value used for CC14; A filter = 168 ppmv.
CPT-28/ 87 ft	26.5	2	3/7/00 9:32	--	69.70	0.00	0.00	2.52	8,860	Differential pressure transducer not functional.
CPT-28/ 87 ft	26.5	2	6/2/00 10:27	0.180	205.00	0.00	0.00	4.71	13,200	
CPT-28 87 ft	26.5	2	6/27/00 9:10	-0.320	165.00	0.00	0.00	5.36	11,800	B filter value used for CC14; A filter = 157 ppmv.
CPT-28/ 87 ft	26.5	2	7/24/00 9:42	0.010	174.00	0.00	0.00	4.05	11,400	
CPT-28/ 87 ft	26.5	2	8/29/00 9:04	0.250	214.00	0.00	0.00	4.67	12,000	
CPT-28/ 87 ft	26.5	2	9/25/00 9:20	-0.160	195.00	0.00	0.00	3.99	9,210	
W15-217/ 115 ft	35.1	3	10/26/99 9:21	-0.560	204.00	0.00	0.00	6.77	9,740	B filter value used for CC14; A filter = 176 ppmv.
W15-217/ 115 ft	35.1	3	11/30/99 12:44	0.220	317.00	0.00	0.00	4.47	12,300	B filter value used for CC14; A filter = 288 ppmv.

Table F-2. Carbon Tetrachloride Concentrations Monitored at the 216-Z-9 Wellfield During Nonoperation of the SVE System, October 1999 Through September 2000. (5 Pages)

Sample Location	Depth (m bgs)	Zone	Sample Date/Time	Differential Pressure (kPa)	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)	Comment
W15-217/ 115 ft	35.1	3	12/29/99 10:13	0.440	370.00	0.00	0.00	3.92	8,780	B filter value used for CCl4; A filter = 333 ppmv.
W15-217/ 115 ft	35.1	3	1/25/00 10:20	--	400.00	0.00	0.00	4.82	9,610	Differential pressure transducer not functional. B filter value used for CCl4; A filter = 366 ppmv.
W15-217/ 115 ft	35.1	3	3/7/00 10:06	--	92.00	1.04	0.00	4.50	9,720	Differential pressure transducer not functional.
W15-217/ 115 ft	35.1	3	6/2/00 10:45	0.460	442.00	2.66	0.00	9.46	13,500	
W15-217/ 115 ft	35.1	3	6/2/00 10:45		376.00	3.23	0.00	8.91	13,500	Duplicate
W15-217/ 115 ft	35.1	3	6/27/00 9:47	-0.290	358.00	2.07	0.00	9.53	11,700	
W15-217/ 115 ft	35.1	3	7/24/00 10:09	-0.180	185.00	1.08	1.00	8.50	10,600	
W15-217/ 115 ft	35.1	3	8/29/00 9:30	0.390	432.00	2.61	0.00	10.30	9,910	
W15-217/ 115 ft	35.1	3	9/25/00 9:50	-0.240	249.00	1.05	0.00	8.83	9,870	
W15-9L/ 189 ft	57.6	6	10/26/99 9:37	-0.160	8.58	0.00	0.00	1.85	9,810	
W15-9L/ 189 ft	57.6	6	11/30/99 12:56	0.290	12.00	0.00	0.00	2.33	12,700	
W15-9L/ 189 ft	57.6	6	12/29/99 10:21	0.900	12.10	0.00	0.00	1.92	8,340	
W15-9L/ 189 ft	57.6	6	1/25/00 10:40	--	14.40	0.00	0.00	2.61	10,400	Differential pressure transducer not functional.
W15-9L/ 189 ft	57.6	6	3/7/00 10:23	--	8.97	0.00	0.00	1.41	10,700	Differential pressure transducer not functional.
W15-9L/ 189 ft	57.6	6	6/2/00 10:58	0.310	12.30	0.00	0.00	2.74	11,800	
W15-9L/ 189 ft	57.6	6	6/27/00 10:00	-0.040	11.90	0.00	0.00	3.15	11,700	
W15-9L/ 189 ft	57.6	6	7/24/00 10:18	-0.280	11.00	0.00	0.00	2.20	10,800	
W15-9L/ 189 ft	57.6	6	8/29/00 9:57	0.530	20.40	0.00	0.00	3.60	11,400	
W15-9L/ 189 ft	57.6	6	9/25/00 10:03	-0.070	10.10	0.00	0.00	1.60	9,100	

-- = no data

bgs = below ground surface

CCl4 = carbon tetrachloride

CH2Cl2 = methylene chloride

CHCl3 = chloroform

MEK = methylethyl ketone

ppmv = parts per million by volume

Appendix F – FY 2000 Soil Vapor Monitoring Data**Table F-3. Carbon Tetrachloride Concentration Standard Analyses,
October 1999 Through September 2000.**

Carbon Tetrachloride Concentration Standard (ppmv)	Carbon Tetrachloride Concentration Analyzed (ppmv)	Date Analyzed	Time Analyzed	B&K Serial Number
25.5	26.3	10/26/99	10:38	1747619
25.5	26.9	10/26/99	11:30	1747619
25.5	25.6	11/30/99	14:00	1747619
25.5	26.3	11/30/99	15:10	1747619
25.5	26	12/29/99	11:30	1747619
25.5	26.7	12/29/99	12:18	1747619
25.5	25.8	01/25/00	11:22	1747619
25.5	26.5	01/25/00	12:10	1747619
25.5	25.9	03/07/00	11:02	1715232
25.5	26.2	03/07/00	11:52	1715232
200	177	03/07/00	0:00	1715232
25.5	25.7	06/02/00	9:08	1715232
200	167	06/02/00	9:46	1715232
25.5	25.9	06/02/00	12:03	1715232
25.5	26.6	06/02/00	12:45	1715232
200	178	06/02/00	12:53	1715232
25.5	26.2	06/27/00	12:40	1715232
25.5	26.2	06/27/00	13:28	1715232
200	165	06/27/00	13:54	1715232
25.5	26.3	07/24/00	12:24	1715232
25.5	26.5	07/24/00	13:10	1715232
200	178	07/24/00	13:22	1715232
25.5	26	08/29/00	11:29	1715232
25.5	26.3	08/29/00	12:17	1715232
200	209	08/29/00	12:22	1715232
25.5	25.8	09/25/00	11:17	1715232
25.5	26.2	09/25/00	12:05	1715232
200	200	09/25/00	12:11	1715232

Appendix F – FY 2000 Soil Vapor Monitoring Data

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Table F-4. Blank Analyses^a, October 1999 Through September 2000.

Sample Location	Sample Date	Sample Time	CCl4 (ppmv)	CHCl3 (ppmv)	MEK (ppmv)	CH2Cl2 (ppmv)	Water (ppmv)
Blank	10/26/99	10:36	0.00	0.00	0.00	0.00	7,710
Blank	10/26/99	11:32	0.00	0.00	0.00	1.27	7,600
Blank	11/30/99	13:57	0.00	0.00	0.00	0.00	9,300
Blank	11/30/99	15:08	0.00	0.00	0.00	0.00	8,690
Blank	12/29/99	11:28	0.00	0.00	0.00	0.00	5,810
Blank	12/29/99	12:20	0.00	0.00	0.00	1.07	5,460
Blank	01/25/00	11:20	0.00	0.00	0.00	0.00	7,260
Blank	01/25/00	12:12	0.00	0.00	0.00	1.00	7,880
Blank	03/07/00	11:00	0.00	0.00	0.00	0.00	5,590
Blank	03/07/00	11:54	0.00	0.00	0.00	0.00	6,520
Blank	06/02/00	9:06	0.00	0.00	0.00	0.00	8,000
Blank	06/02/00	9:24	0.00	0.00	0.00	0.00	9,290
Blank	06/02/00	12:01	0.00	0.00	0.00	0.00	8,330
Blank	06/02/00	12:47	0.00	0.00	0.00	0.00	10,000
Blank	06/27/00	0:00	0.00	0.00	0.00	1.33	9,630
Blank	06/27/00	0:00	0.00	0.00	0.00	1.14	9,990
Blank	07/24/00	12:22	0.00	0.00	0.00	0.00	9,620
Blank	07/24/00	13:12	0.00	0.00	0.00	0.00	9,070
Blank	08/29/00	11:27	0.00	0.00	0.00	0.00	8,620
Blank	08/29/00	12:19	0.00	0.00	0.00	0.00	9,070
Blank	09/25/00	11:15	0.00	0.00	0.00	0.00	6,600
Blank	09/25/00	12:07	0.00	0.00	0.00	0.00	8,040

^a Analyses of the vapor headspace in blank samples of deionized water.

CCl4 = carbon tetrachloride

CHCl3 = chloroform

MEK = methylethyl ketone

CH2Cl2 = methylene chloride

APPENDIX G

**2000 CARBON TETRACHLORIDE
CONCEPTUAL MODEL UPDATE**

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APPENDIX G

2000 CARBON TETRACHLORIDE CONCEPTUAL MODEL UPDATE

Virginia Rohay and Craig Swanson

This appendix presents the current conceptual model as well as working hypotheses concerning the source term, environmental setting, vadose zone and groundwater contaminant distribution, vadose zone and groundwater transport, atmospheric losses, and biological degradation of carbon tetrachloride and associated contaminants in the 200 West Area. The conceptual model of the 200 West Area carbon tetrachloride plume has been continuously refined as additional site-specific data have been collected and as the understanding of dense nonaqueous-phase liquid (DNAPL) behavior in the subsurface has been developed by the scientific community. The conceptual model presented in this report provides an update to and includes information from the conceptual models presented in Rohay and Johnson (1991), Last and Rohay (1991, 1993), Last et al. (1991), Rohay et al. (1994a) and, most recently, Swanson et al. (1999).

Carbon tetrachloride contamination comprises two relatively distinct zones: a higher concentration zone in the source area and a lower concentration zone surrounding the source area. Possible transport mechanisms and distributions of contaminant phases for the high-concentration portion of the plume, which may also contain DNAPL/residual carbon tetrachloride, are depicted in Figure G-1. Because of the differences in the sizes of the three primary disposal sites and the quantities of waste received at these disposal sites, it may be that one transport mechanism and resulting contaminant distribution (e.g., vapor-phase and aqueous-phase migration to groundwater) is more appropriate for one or two disposal sites and that another transport mechanism and contaminant distribution (e.g., DNAPL and aqueous-phase migration to groundwater) is more appropriate for the other(s).

G.1 SOURCE TERM

Between 1955 and 1973, a total of 363,000 to 580,000 L (577,000 to 922,000 kg) of liquid carbon tetrachloride, in mixtures with other organic and aqueous actinide-bearing liquids, was discharged to the soil column at three subsurface disposal facilities (216-Z-9 Trench, 216-Z-1A Tile Field, and 216-Z-18 Crib) near Z Plant (Plutonium Finishing Plant) in the 200 West Area (Figure 2-1). The organic solutions consisted of 50% to 85% by volume carbon tetrachloride mixed with either tributyl phosphate (TBP), dibutyl butyl phosphonate (DBBP), or lard oil (Table G-1). The solvent that was discharged to the soil column also contained dibutyl phosphate (DBP), a degradation product of TBP. These organic solutions made up only approximately 4% to 8% of the total volume of liquid waste discharged to the disposal facilities. The predominant wastes discharged were acidic, high-salt (sodium nitrate), aqueous wastes containing the above organic solutions in saturated amounts (<1%). The organic solutions were periodically discharged to the predominantly water-wetted soil column in small (100- to 200-L) batches. Thus, carbon tetrachloride was introduced to the vadose zone as an aqueous phase and also as a DNAPL.

Three other sites in the vicinity of Z Plant also received some carbon tetrachloride wastes: the 216-Z-12 Crib, the 216-Z-19 Ditch, and the 216-T-19 Crib (Figure 2-1). The 216-Z-12 Crib received analytical and development laboratory waste from Z Plant from 1959 to 1973 and is estimated to have received a small volume of organics, which included carbon tetrachloride (Kasper 1982). The 216-Z-19 Ditch was used to convey process cooling water and steam condensate from Z Plant from 1971 to 1981; apparently, carbon tetrachloride was also occasionally and/or accidentally released to this ditch (e.g., as a result of steam and/or cooling water coil leaks) because heavy organic was noted in the outfall (Rohay and Johnson 1991). Between 1973 and 1976, aqueous waste saturated with carbon tetrachloride was sent to the 242-T Evaporator; during that time, the 216-T-19 Crib received approximately 1,400 kg (880 L) of carbon tetrachloride in the overhead condensate discharged from this evaporator (Rohay et al. 1993).

G.2 ENVIRONMENTAL SETTING

The vadose zone underlying the carbon tetrachloride disposal sites ranges in thickness from 64 m to 69 m and consists primarily of unconsolidated to partially consolidated gravel-, sand-, and silt-dominated deposits of the Pleistocene Hanford and late Miocene to Pliocene Ringold formations (Table G-2). Between these two units, the relatively less permeable Plio-Pleistocene unit, typically containing an increase in calcium carbonate content ("caliche layer"), occurs at approximately 38 to 45 m below the ground surface and ranges in thickness from 2 to 11 m (Table G-3). Cross sections summarizing the stratigraphy near the disposal sites are presented in the main document in Figures 2-2a, 2-2b, and 2-2c.

The physical characteristics of the vadose zone in this area are summarized as follows. The field moisture content is typically higher in the Plio-Pleistocene unit (Table G-2). The permeability of the vadose zone is horizontally and vertically variable in the carbon tetrachloride disposal area: horizontal intrinsic permeabilities range from approximately 10^{-13} to 10^{-10} m²; and corresponding air conductivities range from 0.05 to 25 m/day (equivalent hydraulic conductivities range from 0.5 to 231 m/day) (Rohay and McMahon 1996) (Table G-2). The natural organic carbon content (f_{oc}) of the vadose zone sediments is low (0.11% in silty sand collected from 40- to 43-m depth in well 299-W15-31) (Ford 1996). The soil grain surface area is higher for the silty sand (26.8 m²/g) than for a commercially available silica sand (0.32 m²/g) (Ford 1996). Perched groundwater has been encountered at the Plio-Pleistocene zone, and airflow through the Plio-Pleistocene zone has been observed to be significantly impeded (Rohay et al. 1994b). Clastic dikes, which cross-cut the generally horizontal sedimentary layers, contain sediments that may be more permeable than the host sediments and enhance vertical migration of contaminants. However, the clay skins that typically line the margins of the dikes may be less permeable and inhibit horizontal migration across the dike margins (Fecht et al. 1999).

The wastewater discharges at cribs and ditches near the carbon tetrachloride disposal sites may have created vertical hydraulic barriers to liquid and vapor migration within the vadose zone. For example, liquid discharges to the 216-Z-1/Z-11/Z-19/Z-20/U-14 ditch system south and east of the disposal sites may have formed a hydraulic "curtain," preventing carbon tetrachloride-laden fluid and vapor migration to the south and east through the locally saturated soil column

and thereby driving contaminant migration locally to the north and west. Ponded surface water and perched water may have created horizontal hydraulic barriers for vapor migration. Before the 216-Z-21 Pond was built southeast of the 216-Z-9 site in the 1980's to receive relatively clean storm drain and cooling water, this water was discharged to a low spot on the ground surface on the north and east sides of the 216-Z-9 Trench (this may have been only a short-lived temporary discharge site). Water from the 216-Z-21 Pond is believed to be the source of the perched water encountered at the Plio-Pleistocene unit near the 216-Z-9 Trench at a depth of 28 to 33 m in well 299-W15-216 in 1992 and at a depth of 32.5 to 33.5 m in well 299-W15-220 in 1993 (Rohay et al. 1992, 1993). The 216-Z-21 Pond is 40 m southeast of well 299-W15-216 and received approximately 9.8×10^7 L of water per year until 1995, when liquid discharges to the ground ceased.

Natural recharge from precipitation is estimated to be greater than 100 mm/yr in the carbon tetrachloride disposal area (Fayer and Walters 1995). Recharge from precipitation is higher in the coarse-textured soils with little or no vegetation, as are found in the 200 West Area (Hartman 1999). Natural recharge may be enhanced at the 216-Z-1A Tile Field, which is approximately 1.5 m below grade and was covered with a gravel layer in 1993, although the tile field was covered with a subsurface sheet of 0.05-cm-thick polyethylene in 1964 prior to reactivation. The sheet may focus percolating recharge water to specific vertical migration areas. The top of the 216-Z-9 Trench is 2.5 m lower than the ground surface on its west and south sides.

The uppermost aquifer beneath the 200 West Area is unconfined and lies within an unconsolidated to semi-indurated gravel and sand sequence of the Ringold Formation. The base of the unconfined aquifer is the Ringold lower mud unit. The unconfined aquifer is approximately 66 m thick underlying the carbon tetrachloride disposal sites (Auten and Reynolds 1997). The horizontal hydraulic conductivity in the aquifer ranges from approximately 10^{-3} cm/s to approximately 10^{-6} cm/s. Anisotropy within a sedimentary unit has not been measured at the disposal sites but elsewhere generally ranges from 6:1 to 16:1. The lateral and vertical variability in hydraulic conductivities is illustrated at the carbon tetrachloride disposal site by the production rates of the six pump-and-treat extraction wells, which range from 63 L/min to 310 L/min for similarly completed and configured wells (DOE-RL 1999b). It also appears that hydraulic conductivity decreases with depth in the unconfined aquifer.

The suprabasalt confined aquifer, composed of interbedded sands and gravels of the Ringold Formation, extends from the Ringold lower mud to the top of basalt bedrock. The basalt confined aquifer system is composed of relatively higher conductivity, water-producing interflow/interbed zones separated by lower conductivity basalt flow interiors.

Wastewater discharges since 1943 have created local groundwater water-table mounds; the locations and heights of the mounds have changed as wastewater discharge locations and rates have changed. The presence of the mounds has affected both the direction of groundwater movement, causing radial flow from the discharge areas, and the rate of groundwater movement, under increased hydraulic gradients. With the cessation of liquid discharges, the elevations of both the regional water table and the local groundwater mounds have been declining, resulting in (1) a concomitant increase in the thickness of the vadose zone, and (2) changes in flow directions

and rates that affect the distribution of contaminants in the groundwater and the local definitions of “upgradient” and “downgradient” (DOE-RL 1999a).

In the early years of carbon tetrachloride discharges, the primary groundwater mound occurred north of Z Plant at T Pond, causing southward net flow until the late 1950's. From the late 1950's through the present, the primary groundwater mound influencing flow directions has been at U Pond and its associated ditches and cribs in the southern half of the 200 West Area. All surface liquid discharges were discontinued in 1995 per *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Milestone M-17 (Ecology et al. 1998). This change was accompanied by an accelerated rate of water table decline in the 200 West Area (DOE-RL 2000). Figure G-6 shows this increased rate of water-level decline starting in 1995 for four TX-TY Tank Farm wells located north of the carbon tetrachloride disposal sites. Since 1995, the rate of water-level decline is re-equilibrating to the regional rate of water-level decline in response to decreasing vadose zone drainage.

The current groundwater flow directions underlying the carbon tetrachloride disposal sites are also influenced by the 200-ZP-1 groundwater pump-and-treat system, which has been operating at full scale since 1996. The current regional hydraulic gradient is low (0.001 m/m) and the current regional groundwater flow rate is low (approximately 0.15 m/day) across the site (DOE-RL 1999b); groundwater flow rates and contaminant movement are expected to continue to slow as the groundwater mound subsides and the regional water table declines. The current rate of water table decline is approximately 0.43 m/yr under the carbon tetrachloride site (DOE-RL 2001).

The elevation of the unconfined aquifer water table fluctuates up to 0.2 m/day in response to fluctuations in barometric pressure (Rohay et al. 1993). This water table response, which is more typical for a confined aquifer, is related to the presence of the overlying, less permeable Plio-Pleistocene layer, the relatively thick vadose zone, and atmospheric pressure transients that move both through these sediments and into groundwater wells.

Between 1965 and 1977, the net water table rise was approximately 2 m at the 216-Z-9 site; by 1987 (after U Pond discharges were terminated), the water table had declined to a lower elevation than the level measured in 1965 (Rohay and Johnson 1991). As a result, the location of the pre-1965 capillary fringe beneath the disposal sites was gradually covered with 2 m of saturated soils and then later re-exposed to unsaturated conditions. The thickness of the vadose zone also changed as the water table position changed.

Because of past surface liquid discharges (e.g., U Pond) and a resultant elevated groundwater table, hydraulic head decreases with depth in much of the 200 West Area. Vertical groundwater gradients are downward from the unconfined to the confined system, with hydraulic head differences across the Ringold lower mud becoming more pronounced into the basalt aquifer (Spane and Webber 1995). As the regional water table declines, the head difference between the unconfined aquifer and the lower semi-confined sedimentary units and basalts will become less pronounced. This change should decrease the possibility of dissolved contamination being driven into the lower aquifers. Figure G-7 shows how the hydraulic head differential between the upper and lower aquifers is decreasing near the disposal sites because of the regional water-

level decline and the effects of the 200-ZP-1 pump-and-treat operations. Movement of contamination into the deeper aquifer has also occurred in wells open across both the unconfined and confined sedimentary aquifers (Auten and Reynolds 1997). One such well located near the 216-Z-9 Crib, 299-W15-5, was decommissioned in 1995 to prevent contaminant movement from the upper unconfined aquifer to the lower sedimentary aquifers.

G.3 CARBON TETRACHLORIDE DISTRIBUTION

G.3.1 Mass Balance Calculations

The original inventory of carbon tetrachloride discharged to the three primary disposal sites averaged 750,000 kg. After discharge to the soil column, the carbon tetrachloride in the dissolved and nonaqueous liquid phases could partition into soil vapor, soil moisture and groundwater, and sorbed solid phases. Concentrations of carbon tetrachloride measured in groundwater and soil vapor in 1990 prior to remediation were used with equilibrium partitioning relationships to account for approximately 35% of the total carbon tetrachloride inventory discharged to the soil column (WHC 1993) (Table G-4). However, a later laboratory-based study using carbon tetrachloride and site-specific soils concluded that calculation of carbon tetrachloride soil concentrations using measured vapor-phase concentrations and either empirical relationships or adsorption isotherms to estimate the soil partitioning coefficient can lead to significant error (Yonge et al. 1996). In particular, these relationships do not account for the nonequilibrium partitioning of carbon tetrachloride within soil particles (the apparent “irreversible” adsorption). Therefore, the remaining 65% of the original inventory is believed to be in residual saturation and nonequilibrium sorption sites within the vadose zone and groundwater.

Based on the equilibrium partitioning relationships and the 1990 soil vapor data, 12% of the original inventory was estimated to be in the vadose zone: 4% in soil vapor, 2% in soil moisture, and 6% sorbed to solids (WHC 1993). Based on more recent studies, a significant mass of carbon tetrachloride is believed to be in nonequilibrium sorption sites within the vadose zone soils (Cameron 1997). The extent and magnitude of nonequilibrium sorption has not been determined.

Numerical modeling of vadose zone flow and transport at the 216-Z-9 site indicates that 66% to 90% of the carbon tetrachloride discharged to the 216-Z-9 site was retained in the vadose zone, even under the most conservative bounding conditions of very small residual saturation and large source term (Piepho 1996). In this model, the term “residual saturation” refers to the immovable carbon tetrachloride liquid, including sorbed and entrapped phases. Because the natural organic carbon content in the soils is very small, low values (0.01 and 0.0001) of residual saturation were used in the simulations (Piepho 1996). Larger values of residual saturation would have resulted in less carbon tetrachloride transport to groundwater. The results of this modeling indicate that the rate and amount of carbon tetrachloride transport to groundwater is sensitive to the value of residual saturation assumed for the vadose zone and groundwater.

Evaporation and barometric pumping of carbon tetrachloride is estimated to have removed 21% of the original carbon tetrachloride inventory from the vadose zone between 1955 and 1990 (WHC 1993).

Based on the mass of the carbon source (lard oil and butyl phosphates) and nitrate (electron acceptor) co-disposed with the carbon tetrachloride, Hooker et al. (1996) estimated that 1% of the carbon tetrachloride could have been transformed to chloroform by microbial dechlorination during initial discharge stages (Hooker et al. 1996). The chloroform levels observed in the vadose zone and aquifer correspond to a reductive dechlorination of 1% of the carbon tetrachloride. Biodegradation is probably no longer occurring within the vadose zone and groundwater because the naturally occurring total organic carbon in the soil is insufficient to fuel the process.

The mass of carbon tetrachloride in the upper 10 m of the unconfined aquifer in 1990 was estimated to be 5,250 to 15,740 kg, accounting for 1% to 2% of the original inventory, depending on the value of porosity assumed (Rohay and Johnson 1991) (Table G-5a). The mass of carbon tetrachloride in the aquifer calculated using the smoothed 1996 groundwater contours for comparable conditions (i.e., 10-m aquifer thickness, 30% porosity, no sorption) was 12,203 kg, also accounting for 1% to 2% of the original inventory (Table G-5b). For the 1990 estimate, a soil partitioning distribution coefficient (K_d) of 0.2 mL/g would result in an additional 2% to 8% of the carbon tetrachloride inventory sorbed to aquifer solids (Rohay et al. 1994a). The 1996 calculations evaluated the effect of two different K_d values (0.05 mL/g and 0.114 mL/g) for partitioning carbon tetrachloride between water and solid phases (Table G-5b).

Approximately 81,100 kg of carbon tetrachloride have been removed from the subsurface (vadose zone and groundwater) since remediation of the site began with the soil vapor extraction (SVE) system pilot test in 1991. Between April 1991 and September 2000, SVE removed approximately 76,500 kg of carbon tetrachloride from the vadose zone (Table 4-1). Between August 1994 and September 2000, pump and treat removed about 4,600 kg from the unconfined aquifer (DOE-RL 2001).

G.3.2 Distribution Within Atmosphere

Global background air concentrations of carbon tetrachloride are approximately 0.15 ppb (Shaw et al. 1996).

G.3.3 Distribution Within Vadose Zone

Carbon tetrachloride is found throughout the vadose zone within the approximately 0.2-km² source area. Laterally, the highest concentrations of carbon tetrachloride are consistently located in the vicinity of the 216-Z-9 Trench. Vertically, the highest concentrations are associated with the finer grained, relatively less permeable units (the Hanford lower fine and Plio-Pleistocene units). Carbon tetrachloride is present in the vadose zone as vapor, dissolved, and adsorbed phases.

The highest near-surface vapor concentration measured during a soil-vapor survey prior to remediation was 72 ppmv carbon tetrachloride just north of the 216-Z-9 Trench (Rohay et al. 1992). Maximum vapor concentrations observed at wellheads and deep soil vapor probes, which were measured twice a week for 25 months from 1991 through 1993, exceeded an estimated 10,000 ppmv (the instrument was calibrated up to 2,000 ppmv) total volatile organic compounds at monitoring locations above the Plio-Pleistocene unit and immediately north of the 216-Z-9 Trench (Fancher 1994). At similar depth intervals above the Plio-Pleistocene unit in the 216-Z-1A/Z-18/Z-12 area, maximum concentrations were an order of magnitude lower. However, maximum concentrations from monitoring ports below the Plio-Pleistocene unit were approximately 1,000 ppmv at both the 216-Z-9 and 216-Z-1A/Z-18/Z-12 locations (Fancher 1994).

The highest carbon tetrachloride concentration in the sediment samples collected during drilling of 13 new wells in 1992 and 1993 was 37.8 ppm from a well at the 216-Z-9 Trench (Rohay et al. 1994a). Carbon tetrachloride concentrations exceeded 10 ppm in samples from two other wells in the 216-Z-9 area. In contrast, the highest carbon tetrachloride concentration in a sediment sample from the 216-Z-1A/Z-18 area was 6.6 ppm from a well inside the 216-Z-1A Tile Field. At both locations, all of the maximum carbon tetrachloride sediment concentrations are associated with the interbedded sands and silts of the Hanford formation lower fine unit, laminated silts of the Plio-Pleistocene unit, and/or the top of the caliche. No sediment samples from the source zone area have been available for analysis following remediation.

The highest carbon tetrachloride concentrations in the in situ soil vapor samples collected during drilling were 17,000 to 21,000 ppmv from the Plio-Pleistocene unit in a well at the 216-Z-9 Trench and 10,000 ppmv from the same well at the capillary fringe; the highest in situ soil vapor sample measured from a 216-Z-1A/Z-18 well was 1,400 ppmv (Rohay 1997). Maximum carbon tetrachloride concentrations in soil vapor extracted using the SVE systems were approximately 30,000 ppmv from intervals above the Plio-Pleistocene unit at the 216-Z-9 Trench and 1,500 ppmv from intervals above the Plio-Pleistocene unit at the 216-Z-1A/Z-18 site.

Soil that is saturated with liquid carbon tetrachloride will have an associated equilibrium soil vapor concentration of 120,000 ppmv at 20 °C (Rohay and Johnson 1991). As a rule-of-thumb, for soils saturated with an organic contaminant, standard SVE will produce a gas stream containing one-tenth to one-half the equilibrium soil vapor concentration (Johnson 1993a). Therefore, vapor extraction concentrations greater than 12,000 ppmv of carbon tetrachloride may indicate that the soil near the extraction well is saturated with a nonaqueous-phase liquid. Initial soil vapor concentrations extracted from the 216-Z-9 site were approximately 30,000 ppmv, suggesting that a carbon tetrachloride DNAPL was present above the Plio-Pleistocene layer prior to remediation. The high in situ soil vapor concentrations of 17,000 to 21,000 ppmv observed prior to remediation during drilling also suggest the presence of DNAPL at the 216-Z-9 site.

The high vapor concentration (>10,000 ppmv) observed in the in situ soil vapor sample collected at the capillary fringe at the 216-Z-9 site prior to SVE remediation suggests that DNAPL reached the aquifer. Whether a DNAPL penetrates the capillary fringe and enters the aquifer is dependent on contaminant density, interfacial relationships, grain sizes, soil packing, and degree of cementation. The DNAPL will accumulate at the capillary fringe until it develops sufficient

head that it can break through (overcome entry pressure) into the aquifer as fingers of preferential flow.

The high carbon tetrachloride concentrations measured during baseline monitoring from 1991 through 1993 prior to remediation may also suggest the presence of DNAPL. As a rule-of-thumb, “full-scale OVA readings of 1,000 to 2,000 ppmv are probably a reasonable indication of the presence of DNAPL” (Pankow and Cherry 1996, p. 416). Fancher (1994) recorded maximum organic vapor analyzer (OVA) measurements of approximately 1,000 ppmv at the 216-Z-1A/Z-18/Z-12 site and exceeding 2,000 ppmv at the 216-Z-9 site, above the lower permeability Plio-Pleistocene layer, and maximum OVA measurements of approximately 1,000 ppmv at the 216-Z-1A/Z-18/Z-12 and 216-Z-9 sites below the Plio-Pleistocene layer.

Nonaqueous-phase liquid carbon tetrachloride has not been observed in the vadose zone.

The locations of the maximum carbon tetrachloride rebound in the vadose zone following SVE operations were the same in 1997, 1998, 1999, and 2000. The persistence of these rebound locations may indicate nearby locations of DNAPL and/or residual carbon tetrachloride. The 1997 rebound study and 1998, 1999, and 2000 monitoring indicated that at most locations within the influence of the SVE systems, much of the readily available carbon tetrachloride has been removed. The lower permeability Plio-Pleistocene layer, however, appears to be a continuing source of carbon tetrachloride soil vapor (Rohay 1997, Section 6.0 of this report). The SVE system is able to draw air through the higher permeability sands and gravels but not effectively through the lower permeability silts and carbonate-cemented sandy gravel of the Hanford lower fine and Plio-Pleistocene units.

The spacing and various open intervals of the current SVE extraction and monitoring wells do not provide full coverage of the contaminated vadose zone in the disposal site area. Thus, some readily available carbon tetrachloride contaminant in relatively permeable sediments may still remain in the vadose zone soils that are not currently impacted by the SVE system operations (Cameron 1997, Rohay 1997).

The limited number of monitoring locations, especially below the Plio-Pleistocene layer, and difficulty in predicting contaminant migration pathways from the surface disposal sites contribute to the uncertainty in describing the overall contaminant distribution in the vadose zone.

In the far field, carbon tetrachloride vapor has been detected in wells under construction throughout much of the 200 West Area since 1987 (Rohay and Johnson 1991). Most of the reported detections have been from below the Plio-Pleistocene layer, often in the capillary fringe just above the water table. The distribution of wells with detections below the Plio-Pleistocene layer matches fairly well with the distribution of carbon tetrachloride dissolved in the groundwater, suggesting that the source of the vapor may be volatilization from groundwater. However, some wells, notably those approximately 300 m west of the 216-Z-18/Z-12 disposal sites, also had detections above the Plio-Pleistocene layer, suggesting that carbon tetrachloride may have migrated laterally west from the disposal sites or east from the 218-W-4C Burial

Grounds. (These detections of carbon tetrachloride occurred prior to vadose zone remediation using SVE.)

Plutonium and americium co-contaminants are distributed within the upper 30 m of the vadose zone (20 to 30 m below crib bottom), based on characterization of the 216-Z-1A Tile Field in 1976 (Price et al. 1977). The transuranic (TRU) contamination at the carbon tetrachloride sites may have been carried downward through a combination of acidic waste liquids and organic-complexant mixtures (Price et al. 1979, Johnson and Hodges 1997). After the disposal occurred, both the acidic and organic complexes are expected to diminish via soil pH neutralization and biodegradation processes, and plutonium and americium would be expected to absorb strongly to the Hanford site sediments (Hartman 1999).

G.3.4 Distribution Within Groundwater

The plume of dissolved carbon tetrachloride extends over 11 km² in the unconfined aquifer underlying the 200 West Area (Hartman et al. 2001) (Figure G-2). It has been previously concluded that because the zone of highest concentrations (4,000 to 8,000 µg/L) has in the past included the 216-Z-9 Trench, carbon tetrachloride discharged to the trench may be providing a continuous source of contamination to groundwater (BHI-00720, Rev. 3). However, recent concentrations have been decreasing at 200-ZP-1 pump-and-treat extraction well 299-W15-32 (Figure G-5) located at the northeast corner of the trench. The observed decrease suggests that either the vadose zone is not currently a continuing source or that the rate of mass removal by groundwater extraction exceeds the rate of mass contribution from the vadose zone.

Concentrations at well 299-W15-32 were observed to increase following the extended shutdown from June 29, 1999 to February 2, 2000 (Figure G-5). If the vadose zone is a continuing source of carbon tetrachloride to the groundwater, or if DNAPL is present in groundwater, it would be expected that some rebound would have occurred during the shutdown. Conversely, if there were no continuing source, dissolved concentrations would have been expected to remain at about the same concentration during and following shutdown. The overall increase could be interpreted to mean that:

- A source of residual carbon tetrachloride continues to contribute to groundwater from the vadose zone.
- A source of residual DNAPL is present below the water table.
- Both vadose zone and groundwater sources are contributing.
- Dissolution of residual DNAPL, in either a vadose source and/or in groundwater, is slow compared to the pumping-induced groundwater velocity across the site so overall groundwater concentrations tend to decline during pumping.

The first few carbon tetrachloride measurements following shutdown appear to be on the same declining trend exhibited prior to shutdown (Figure G-5). Then concentrations at the extraction

well increase to pre-shutdown levels. The delay in increased concentrations observed at the extraction well may indicate that the source is at some distance from the well and that groundwater had to travel from the source to the well before the increase could be observed. Based on Darcy's Law, the source would be 8.5 m (28 ft) from the well, assuming:

- The time required for the groundwater to travel from the source to the well was 57 days (February 2, 2000 to March 30, 2000)
- The hydraulic conductivity is 15 m/d (DOE-RL 1999b)
- The hydraulic gradient is 0.001 m/m (DOE-RL 1999b)
- The effective porosity is 10% (conservative estimate) (DOE-RL 1999b).

Well 299-W15-32 is 7.4 m from the northeast corner of 216-Z-9 and 26.3 m from well 299-W15-218, where high concentrations were observed at the capillary fringe during drilling in 1993.

It is interesting to note that the declining concentration trends prior to shutdown and following the increase after shutdown are the same.

At some time in the future, tailing of groundwater concentrations is expected to occur as carbon tetrachloride is removed from the more permeable zones and becomes diffusion limited moving from the less permeable zones. Tailing should occur even if carbon tetrachloride is present as dissolved phase, as residual DNAPL, as a vadose zone source, or from a combination of these factors. There are not enough data at this time to determine which of these conditions is present (other than the dissolved phase). Previous modeling work by Piepho (1996) implied that residual DNAPL should be present beneath the water table.

Although the centroid of the plume has not migrated significantly under natural driving forces, the perimeter of the plume appears to be migrating laterally to the south and north (Hartman et al. 2001). Dissolved concentrations measured in well 699-39-79 at the western perimeter of the plume increased by an order of magnitude between March 1987 and August 1988, suggesting the arrival of the plume at that time (Dresel et al. 1993). Concentrations of carbon tetrachloride at well 699-39-79 have declined since 1996 to below maximum contaminant levels because clean groundwater has been injected at nearby well 299-W15-29 (Figure G-2).

Based on dissolved-phase concentrations in the upper 10 m of the unconfined aquifer in 1990, and prior to remediation, nearly 60% of the groundwater mass of carbon tetrachloride was contained within about 10% of the area of the plume (Rohay and Johnson 1991) (Table G-5a). The centroid of the plume is apparently expanding in response to remediation operations, with the dissolved phase moving most notably toward the three northern extraction wells (Figure G-3). It is recommended that the total mass in the centroid should be recalculated, compared to the original estimates, and used to estimate remediation time using pump-and-treat technology.

The shape and location of the groundwater plume for the high-concentration area ($>4,000 \mu\text{g/L}$) lends itself to at least three explanations or possible combinations of these explanations (Figure G-3). First, the location of the high-concentration area northwest of the 216-Z-9 disposal site implies that the groundwater mound created at the U Pond and other nearby disposal facilities produced a hydraulic flow field that moved contamination this direction. Recreating the development of the mound and disposal and migration of carbon tetrachloride contamination using a numerical computer model or other analytical tools would help confirm and quantify this type of movement.

It should be noted that the groundwater plume map for 1996, prior to substantial remediation efforts, may not truly represent the baseline plume shape at that time because of the lack of monitoring locations northwest of 216-Z-9 between wells 299-W15-32 and 299-W25-31A. The centroid of the plume may in fact be located closer to 216-Z-9, beneath the Z Plant surface facilities. If this is correct, then the highest groundwater concentrations have been or would be beneath Z Plant. This explanation is supported by the increasingly high concentrations measured at wells 299-W15-31A (from $3,260 \mu\text{g/L}$ in 1996 to $6,500 \mu\text{g/L}$ in 1999) and 299-W15-1 ($1,180 \mu\text{g/L}$ to about $6,350 \mu\text{g/L}$ in 1999). Both of these wells are in the induced flow path under Z Plant to extraction wells 299-W15-33 and 299-W15-34 (Figure G-3).

A second possible explanation for the current shape of the groundwater plume is that carbon tetrachloride contamination was directed to the northwest by relatively continuous lower permeability sediment units, particularly the Plio-Pleistocene unit. This unit would be a prime candidate for this explanation, but is thought to dip to the south in the area of the disposal sites based on regional geologic information. However, recent surface geophysics work by the University of South Carolina (Waddell et al. 1999) suggests that the Plio-Pleistocene at the north end of the 216-Z-9 Trench dips in a northerly direction. This latest information therefore supports the idea that carbon tetrachloride may have moved to the north or northwest, and then migrated through the Plio-Pleistocene unit to the groundwater.

A third possible explanation for the distribution pattern of the groundwater plume is that one or more additional, as yet undocumented, sources of carbon tetrachloride may have contributed to groundwater contamination in this area. The highest groundwater concentrations have been measured not only beneath the 216-Z-9 Trench, which is a known source, but also in the area northwest of Z Plant, where no sources are documented. Possible sources of carbon tetrachloride contamination in the groundwater northwest of Z Plant could include the following:

- Discharges of liquid and carbon tetrachloride the 216-Z-12 Crib at volumes higher than originally estimated (Kasper 1982)
- Leakage of carbon tetrachloride liquids from the 216-Z-12 head end pipe
- Other, as yet undocumented sources of carbon tetrachloride from soil column disposal within or near Z Plant (e.g., may be associated with train operations).

The 216-Z-7 Crib east of the 231-Z Building (Figure 2-1) may also be a potential source of carbon tetrachloride contamination. Continuous measurements of carbon tetrachloride concentrations in air for 87 days in 1995 at a monitoring station north of the 216-Z-9 site indicated that the 216-Z-7 Crib was a source of the carbon tetrachloride (Shaw et al. 1996). At this monitoring station, an air sample was drawn alternately from each of two heights (0.88 and 2.65 m) every 10 minutes and analyzed for carbon tetrachloride concentrations as part of a determination of carbon tetrachloride flux to the atmosphere. The concentrations were compared to wind directions at the time of sampling to identify locations of carbon tetrachloride sources.

The source of the secondary maximum in groundwater near the T-TX-TY Tank Farms and T Plant is unknown (Figure G-2). One hypothesis is that it migrated from the 216-Z-9 area, i.e., it was hydraulically driven north because of mounding at U Pond. There may have been another source of carbon tetrachloride near T Plant. Carbon tetrachloride discharges to the 216-T-19 Crib may have contributed to this portion of the groundwater plume. A computer modeling effort would help evaluate the reasonableness of these hypotheses.

The source of the low-concentration lobe of the carbon tetrachloride plume southwest of the former U Pond is also uncertain (Figure G-2). If the source of this contamination was from early years of carbon tetrachloride disposal, when the groundwater flow was to the south, and if concentrations were much higher at that time, the low concentrations might reflect displacement and dilution by the large volume of U Pond discharges. However, if concentrations were not much higher originally, the U Pond discharges presumably should have displaced or diluted this hypothetical early plume. Contamination in this part of the aquifer may be a result of vapor transport from the source cribs or vapor cycling (carbon tetrachloride volatilizing from contaminated groundwater, diffusing through the vadose zone, and then contaminating clean groundwater).

Carbon tetrachloride has been detected at or less than 1% of its theoretical solubility limit in water (800,000 $\mu\text{g/L}$). Chlorinated hydrocarbon solvents are commonly observed to be at concentration levels in groundwater far below their aqueous solubility limits, even when the aquifer is believed to contain separate phase liquid (Anderson et al. 1992). Possible explanations proposed by Anderson et al. (1992) include the preferential formation of thin flat pools rather than vertical fingers of DNAPL, which would reduce the cross-sectional contact area between the oncoming groundwater and the DNAPL; dilution of small aqueous plumes by dispersion downgradient from the source; and dilution of thin and/or narrow aqueous plumes by uncontaminated water in monitoring wells screened over lengths of several meters, lengths which are large relative to the dimensions of the plume. In addition, the wells monitor the top of the aquifer and may not sample carbon tetrachloride present at depth. In the 200 West Area, the wells are sampling an increasingly smaller portion of the top of the unconfined aquifer as the water table elevation declines.

As a rule-of-thumb, “dissolved concentrations that exceed 1% of the effective solubility should probably be cause for serious consideration of the presence of a DNAPL phase” (Pankow and Cherry 1996). Dissolved concentrations of approximately 8,000 $\mu\text{g/L}$ have been observed at an extraction well (299-W15-32) adjacent to the 216-Z-9 Trench while pumping, which intermixed the dissolved concentrations with cleaner groundwater. Numerical modeling of vadose zone

flow and transport at the 216-Z-9 site indicates that liquid carbon tetrachloride reached the aquifer at that location (Piepho 1996). The continuing presence of relatively high dissolved concentrations in groundwater in the immediate vicinity of the 216-Z-9 Trench also suggests that a DNAPL is slowly dissolving within the aquifer or continuing to migrate from the vadose zone. However, as discussed previously, declining groundwater concentrations at extraction well 299-W15-32 would seem to make DNAPL a less significant contributor of contamination than the dissolved phase. If, as the numerical modeling suggests, carbon tetrachloride reached the aquifer in the first 7 years of discharge and ponded at the capillary fringe present in 1962, the carbon tetrachloride may have been trapped and dissolving while it was buried for 25 years within the saturated zone as a result of the elevated water table from 1965 to 1987.

The rebound of carbon tetrachloride concentrations in groundwater following pump-and-treat operations might indicate the presence of DNAPL. While concentrations are generally increasing at the extraction wells and the plume is expanding toward these wells, a large-scale rebound test has not been conducted. An 8-month period of shutdown at extraction well 299-W15-32 did show what appears to be rebound. Initially, concentrations continued to decrease, but later displayed a relatively sharp increase (Figure G-5). This slightly delayed increase implies some contributing source approximately 8.5 m from the extraction well.

The estimated change in location of the 4,000- $\mu\text{g/L}$ contour from southwest of Z Plant to beneath Z Plant after 4 years of pump-and-treat operations implies either that DNAPL may not be present in the aquifer southwest of Z Plant or that the rate of dissolution of residual DNAPL in groundwater is slow compared to the pumping-induced groundwater velocity in this area (Figure G-4). At the least it indicates that the dissolved phase is the dominant contaminant form in this area at the current concentration levels. At some lower concentration, another phase may dominate (e.g., dissolution of residual DNAPL). This change in shape/position can be explained by changes in the hydraulic flow field produced by the groundwater extraction and injection wells (DOE-RL 2000).

The mass of carbon tetrachloride dissolved in the aqueous wastewater discharges to the soil column was 10,560 kg ($13.2 \times 10^6 \text{ L} \times 800,000 \mu\text{g/L}$ at solubility limit $\times 1 \text{ kg}/10^9 \mu\text{g} = 10,560 \text{ kg}$) (Rohay and Johnson 1991). This value is the same order of magnitude as the inventory calculated for the upper 10 m of the aquifer (5,250 to 15,740 kg) (Table G-5a). Thus, solely aqueous-phase carbon tetrachloride could be the primary source of groundwater contamination; a DNAPL source would not be required to produce the groundwater inventory in the upper 10 m, assuming no sorption of carbon tetrachloride to aquifer solids. (This calculation assumes that the total volume of liquid discharged to each site was all aqueous phase containing carbon tetrachloride at its solubility limit and that all the liquid discharged reached groundwater. These quantities of carbon tetrachloride -- Z-9 = 3,300 kg; Z-1A = 4,200 kg; Z-18 = 3,100 kg -- represent approximately 2% of the carbon tetrachloride discharged to these sites.)

DNAPL has never been observed directly in groundwater. The probability of recovering residual DNAPL during drilling and sampling is very low because of its tendency to remain in the sediment pore spaces even adjacent to open wells or well screens. The possibility of recovering residual DNAPL is not very likely given the relatively small number of groundwater wells installed in the disposal areas. There is a higher likelihood of finding DNAPL in the vadose

zone, because of the higher well density. However, DNAPL has never been detected in the vadose zone, either.

Numerical modeling of vadose zone flow and transport indicates that at lower residual saturation values, dissolved and nonaqueous-phase liquid carbon tetrachloride can penetrate deeply into the unconfined aquifer, but likely would not have reached the bottom of the aquifer (Piepho 1996). The depth of penetration depends on the level of residual saturation assumed for the vadose zone and the groundwater flow rate.

Dissolved carbon tetrachloride has been observed deep within the unconfined aquifer (i.e., between 10 m below the water table and the base of the unconfined aquifer) at the following locations:

- 216-Z-9 site (wells 299-W15-6 and 299-W15-5) (Rohay and Johnson 1991, Auten and Reynolds 1997)
- West and north of Z Plant (wells 299-W15-17, 299-W15-7, 299-W15-10, 299-W10-22, 299-W14-14, 299-W10-24, 299-W15-25, and 299-W15-30 (Hartman 1999; BHI 1997, 1998; Swanson et al. 1999)
- Near U Plant (wells 299-W19-34A, 299-W19-34B, 299-W19-18, and 299-W19-4) (Ford 1995)
- Near T Plant (well 299-W11-32) (Newcomer et al. 1995).

Dissolved carbon tetrachloride has also been observed within the confined aquifer system (i.e., in the gravels below base of unconfined aquifer) at wells at the following locations:

- South of the 216-Z-9 site (well 299-W15-5; well probably served as preferential pathway) (Auten and Reynolds 1997)
- East of the 216-Z-9 site (well 299-W14-9) (DOE-RL 1999b)
- Near the T-TY-TX Tank Farms (wells 299-W10-24 and 299-W14-14) (Hartman 1999)
- Near U Plant (well 299-W19-34B) (Ford 1995).

The observed distribution of dissolved carbon tetrachloride in the high-concentration portion of the groundwater plume is inconsistent with a vapor-phase source. A vapor-phase source should result in a shallow (1- to 2-m thick) vertical distribution in the aquifer due to the relatively slow process of molecular diffusion, the process by which the carbon tetrachloride vapor enters the groundwater (Pinder and Abriola 1986). However, carbon tetrachloride contamination is found at depths greater than 30 m below the water table.

The 200-ZP-1 groundwater pump-and-treat system is containing carbon tetrachloride within the 2,000- $\mu\text{g/L}$ contour (DOE-RL 2000). Between August 1994 and September 2000, this system has removed about 4,570 kg of carbon tetrachloride, which is 72% to 216% of the mass initially estimated in 1990 to be contained within the 2,000- $\mu\text{g/L}$ contour (Table G-5). The persistence of the carbon tetrachloride concentrations implies that the initial mass calculation was incorrect (e.g., because of greater depth distribution), that the K_d is greater than assumed, and/or possibly the presence of a continuing source of carbon tetrachloride (residual or DNAPL). A revised estimate of carbon tetrachloride mass is needed.

Low (<10 pCi/L) plutonium-239/240 and americium-241 activities were detected in well 299-W15-8 adjacent to the 216-Z-9 Trench on two sampling dates (May 7, 1990 and November 13, 1991). The well went dry sometime after January 1992 and can no longer be sampled (Hartman 1999). The plutonium and americium contamination observed in groundwater at the 216-Z-9 site in well 299-W15-8 may signify soil column breakthrough or a preferential pathway in the well. Followup sampling of groundwater extracted by the pump-and-treat system at 216-Z-9 did not detect mobile species indicative of TRU (Hartman 1999). "Extraction well 299-W15-32, located next to the 216-Z-9 Trench, has been sampled for plutonium isotopes for the last several years and for neptunium-237 and americium-241 in FY 1998, without detecting any plutonium, neptunium, or americium. However, because this well draws water from a considerable area, the samples may not be representative of contaminant activities directly under the trench" (Hartman 1999).

Radionuclide sampling for technetium-99, tritium, and iodine-129 at the 200-ZP-1 treatment system revealed elevated levels of technetium-99 at extraction wells 299-W15-32 and 299-W15-35 in FY 1999 (DOE-RL 2000). Concentrations were 286 pCi/L and about 200 pCi/L, respectively. Results for tritium in the northern three extraction wells ranged from 2,160 to 4,450 pCi/L, and were non-detect for iodine-129. The elevated technetium-99 results imply that either this contaminant is moving from the plume associated with the TX-TY Tank Farm to the north, or is coming from some other source. Historically, some technetium-99 was detected near the 216-Z-9 Trench (410 pCi/L in 1992 at well 299-W15-8).

G.4 CARBON TETRACHLORIDE TRANSPORT

G.4.1 Vadose Zone/Atmosphere Interface

Atmospheric pressure fluctuations appear to constitute a significant release mechanism for carbon tetrachloride vapor out of the vadose zone both through the soil surface and through boreholes perforated or otherwise open to the vadose zone. The soil-surface flux of carbon tetrachloride measured at the ground surface in the vicinity of the 216-Z-9 site in 1992 and 1993 using the EMFLUX® (Quadrel Services, Inc.) soil vapor technology ranged from 0 to 923 $\text{ng/m}^2/\text{min}$ (0 to 485 kg/yr for a 1- km^2 area) (Rohay et al. 1994a). The average soil-surface flux for the area overlying the groundwater plume in 1990 was estimated to be 285 $\text{ng/m}^2/\text{min}$, or 1,800 kg/yr , assuming carbon tetrachloride partitions from groundwater according to Henry's Law, diffuses from groundwater to 1 m below ground surface, and then is barometrically swept

out (WHC 1993). The 1994-1995 flux of carbon tetrachloride to the atmosphere from a 1-km² area that includes the carbon tetrachloride discharge sites was 1,200 kg/yr, based on site-specific mass balance and tracer-ratio measurements (includes soil and wells) (Shaw et al. 1996).

It is estimated that, between 1955 and 1990, 18% of the total carbon tetrachloride inventory was lost to the atmosphere through natural soil flux at the ground surface (WHC 1993). The depth over which carbon tetrachloride is removed by barometric pumping was estimated in 1992 to be 1 m (WHC 1993). In 1992, barometric pressure fluctuations averaged 1.4% of the average barometric pressure. Assuming that a 1.4% pressure increase results in a 1.4% volume decrease in the soil vapor, on an annually averaged basis barometric pumping would sweep out air in the pores of the top 1.4% of the vadose zone (1.4% of 64 m) half of the time.

The 2-m rise of the water table between 1965 and 1977 would have displaced contaminated soil vapor from the vadose zone to the atmosphere. This effect was not included in the 1990 estimates of vadose zone losses.

The wells “breathe” in response to atmospheric pressure changes and other meteorological phenomena. The carbon tetrachloride released from wells in the vicinity of the cribs between 1955 and 1990 was estimated to be 22,200 kg, or 3% of the discharged inventory (WHC 1993). Thus, an estimated 21% of the total carbon tetrachloride inventory may have been lost to the atmosphere via the soil surface and borehole flux since soil column disposal was initiated (WHC 1993).

G.4.2 Vadose Zone

Once discharged to the crib, the liquid wastes infiltrated into the underlying soils and migrated predominantly downward. An average infiltration rate or recharge rate into the soil column can be estimated for each crib from the area of the crib bottom and average annual discharges. These range from 1 to 10 L/m²/day (Table G-6). Average infiltration rates from percolation tests in the 216-Z-20 and 216-Z-21 Crib areas have been reported as ranging from 1,900 to 2,850 L/m²/day (Last and Rohay 1993). Thus, the field-measured infiltration rate of the soil column far exceeds the estimated recharge rate from the cribs. Assuming that the behavior of the liquid wastes discharged was similar to that of water used in the percolation tests, it is doubtful that the soil column ever became fully saturated or that the cribs exceeded the infiltration capacity, at least for any appreciable period of time. Crawley (1969), however, did report that a buildup of liquid waste was suspected in the head end of the 216-Z-1A Tile Field. This suggests that the infiltration capacity of the first one-third of the crib had been exceeded by the discharge volumes, perhaps as a result of plugging of the soil pores by fine particulates or other solids. It should also be noted that the 216-Z-1A Tile Field had received other liquid wastes from 1949 to 1959, so the soil column was already partially saturated.

As a first approximation, the likelihood that carbon tetrachloride in an aqueous or nonaqueous phase reached the groundwater can be estimated by comparing the total volume discharged to the column pore volume beneath each crib (i.e., bottom area of the crib multiplied by depth to water multiplied by porosity, assuming 30% porosity). Results of such calculations indicate that the 216-Z-1A and 216-Z-18 waste disposal facilities received only 12% and 29% of their estimated

column pore volumes, respectively, while the 216-Z-9 Trench received 142% of its column pore volume (Table G-6). It must be noted that these are only rough estimates and that the wastes were discharged over periods of years rather than at one time. Additional drainage would also have occurred under unsaturated conditions, after discharges were terminated. If the porosity were smaller or if the entire column pore volume were not used (e.g., if the wastes migrated down preferential pathways such as unsealed wells or if the wastes did not spread out evenly over the crib floor), the values would be higher. Conversely, if the waste plume spread out laterally, increasing its column pore volume, these values would be smaller. In any case, the 216-Z-9 Trench is more likely to have had waste fluids containing carbon tetrachloride reach the groundwater strictly by downward percolation.

Numerical modeling of vadose zone flow and transport indicates that both dissolved and nonaqueous-phase liquid carbon tetrachloride migrated through the vadose zone and reached the unconfined aquifer below the 216-Z-9 Trench (Piepho 1996). In the simulations, the flux of carbon tetrachloride from the vadose zone into the aquifer primarily depends on the amount of carbon tetrachloride held in residual saturation in the vadose zone (Piepho 1996). However, for both values (0.01 and 0.0001) of residual saturation used in the simulations, the numerical modeling results indicate that carbon tetrachloride continues to enter the aquifer for a long time (at least 38 years and likely for longer in the simulations) after the initial discharge to surface disposal sites (Piepho 1996). In addition to assuming potential values for residual saturation, several simplifications were applied and the physical properties of pure carbon tetrachloride were used rather than those of the carbon tetrachloride organic mixtures.

Numerical simulations of wastewater migration beneath the 216-Z-9 Trench suggest some horizontal spreading of the aqueous plume may have occurred at the Hanford coarse-grained unit/fine-grained unit boundary, but that little lateral spreading may have occurred below that (Last and Rohay 1993). Piepho (1996) indicates that greatest horizontal spreading of the aqueous phase in the vadose zone appears to be in the Plio-Pleistocene unit; in these numerical simulations, the ratio of the horizontal to vertical saturated hydraulic conductivity was 10. In these simulations, there is essentially no lateral spreading of the liquid carbon tetrachloride phase (Piepho 1996). Wright et al. (1994) inferred a near-vertical moisture plume beneath the carbon tetrachloride cribs, with some spreading occurring only on the Hanford formation lower fine/Plio-Pleistocene unit surfaces. Field measurements indicate that the lateral spread of radionuclides beyond the perimeter of the 216-Z-1A Tile Field was limited to a 9-m-wide zone (Price et al. 1979), suggesting that the spread of waste liquids was minimal or that the plutonium was filtered in that distance. In conclusion, the aqueous-phase carbon tetrachloride infiltrates predominantly downward from the near-surface discharge sites; any lateral spreading is primarily associated with coarse/fine layer contacts.

Because liquid carbon tetrachloride is relatively immiscible in water and the soil column is assumed to be water-wetted, the carbon tetrachloride would move under its own hydraulic gradient. Wright et al. (1994) concluded, based on their measurements, that the hydraulic conductivity of liquid carbon tetrachloride through the subsurface soil samples was much higher than that of water or of an aqueous carbon tetrachloride solution, and that the differences were greater in the finer grained sample.

As nonaqueous-phase liquid carbon tetrachloride moves down through the soil column, some of the liquid carbon tetrachloride will be held in the soil pores by capillary forces as residual liquid. Based on studies of carbon tetrachloride hydraulic conductivities in soil samples, Conca et al. (1992) concluded that the retention of liquid-phase carbon tetrachloride was about half that of water or an aqueous-phase carbon tetrachloride solution. Thus, if the field moisture content of the soil were 5% under a given unsaturated flow condition, it can be estimated to retain 2.5% carbon tetrachloride under the same conditions. It should be noted that these are strictly empirically derived estimates, based on two samples, and should be viewed with some caution (Rohay et al. 1994). In addition to immobilization by capillary forces, some of the discharged carbon tetrachloride was retained in the vadose zone through mechanisms such as equilibrium (reversible) and nonequilibrium (nonreversible) sorption to soil and entrapment of DNAPL/dissolved liquids in dead-end pore spaces. Through all these mechanisms, residual saturation of contaminated aqueous-phase and nonaqueous-phase liquids will be left along the contaminant migration path.

A rough estimate of how far the organic nonaqueous-phase liquid may have traveled downward through the soil column as a continuous organic liquid phase (i.e., at saturations greater than the residual) can be calculated by assuming a single residual saturation of 2.5% for the entire pore column volume and by assuming that the organic was evenly distributed across the crib bottom area. Table G-7 lists the relative depth of nonaqueous-phase liquid migration for each facility. Note that the migration depth calculated for the 216-Z-9 Trench is over an order of magnitude greater than that of the other two cribs and is potentially below the water table. It also seems plausible that much of the organic nonaqueous-phase liquid may have been retained in the soil column because of the residual saturation. Numerical modeling of vadose zone flow and transport indicates that 66% to 90% of the carbon tetrachloride discharged to the 216-Z-9 site was retained in the vadose zone (Piepho 1996). It should be noted, however, that DNAPL characteristically moves nonuniformly downward through the vadose zone (Cohen et al. 1993), so this estimate is probably high. The distribution of plutonium and americium to 30-m depth beneath the 216-Z-1A Tile Field suggests that these estimates are minimum values.

Another potential indicator of the distribution of the organic phase is the distribution of the associated radionuclide co-contaminants. Transuranics (primarily plutonium-239 and americium-241) discharged to the disposal sites may have been carried in association with the organic-complexant liquid phase. The behavior of the transuranics in such a mixture as the DNAPL moves through the soil is unknown. Typically, when plutonium and americium are released as solutes, they are retained in the upper few meters of the soil column (Johnson 1993b). However at the 216-Z-1A Tile Field, these radionuclides were discharged as co-contaminants with the DNAPL-complexant mixture and are found at depths up to 30 m below the bottom of the tile field (Price et al. 1979). This behavior has been previously attributed to the destruction of the sorptive capacity of the soils by the acidic waste stream. However, the abundant amounts of calcium carbonate in the soil column could have easily neutralized the acid. For example, at a pH of 1 (0.1 M), which is more acidic than the discharged aqueous waste stream (pH of 2.5), the total volume of aqueous waste discharged to the 216-Z-1A Tile Field would have contained approximately 500 kmol of acid. Assuming a calcium carbonate content of 1%, the first meter of the soil column beneath this crib contains 588 kmol of calcium carbonate, which is more than enough calcium carbonate to neutralize this amount of acid (Johnson 1993b). Thus, it seems

more probable that the greater depth distribution of transuranics in this crib is due to migration with the solvent-complexant phase. Beneath the 216-Z-1A Tile Field, increases in concentrations of plutonium and americium with depth are generally associated with an increase in the silt content of the sediments or with boundaries between sedimentary units. Because similar solvent-chemical conditions existed for disposal at the other carbon tetrachloride sites, similar depth distributions of significant transuranic concentrations could be encountered at these other sites.

Volatilization of carbon tetrachloride from aqueous- and nonaqueous-phase liquids within the disposal cribs and the vadose zone results in vapor-phase carbon tetrachloride in soil pores. Contaminated vapor can move downward and laterally by molecular diffusion and by advective flow. Vapors can diffuse along a chemical gradient from high concentration to low in any direction (including upgradient with respect to the groundwater flow direction). The presence of a relatively low-permeability surface cover, such as a building foundation or soil horizon, can also enhance the lateral extent of diffusion. The presence of locally saturated or near-saturated vadose zone sediments underlying other aqueous waste disposal sites can inhibit the lateral extent of diffusion.

Because of the high molecular weight of carbon tetrachloride compared to air, the density of saturated carbon tetrachloride vapor is greater than uncontaminated vapor in the vadose zone (Table G-8). This contrast in densities can result in density-driven advective flow, which would move carbon tetrachloride vapor downward and laterally from the disposal facilities. Numerical modeling studies show that in high-permeability soils, density-induced advection can be a significant transport mechanism that equals or exceeds the effect of diffusion; large density gradients may cause downward advection with velocities on the order of meters per day (Pankow and Cherry 1996). The threshold soil permeability above which density-induced advection becomes important for the chlorinated solvents appears to be on the order of 10^{-11} m² (equivalent to a hydraulic conductivity of 10^{-2} cm/sec, which is typical for medium-coarse clean sand and gravel) (Pankow and Cherry 1996, Freeze and Cherry 1979). In experiments with trichloroethylene (TCE), which has a relative vapor density (1.35) similar to that of carbon tetrachloride (1.62), density-driven flow was found to be very important in a pea gravel but played only a minor role in a medium sand (Pankow and Cherry 1996). Pankow and Cherry (1996) note that the vapor source must be maintained at a high concentration in order to maintain high-density gradients and that the greater the thickness of the vadose zone, the greater the advective effects due to density gradients. Density-driven advective vapor flow may have contributed to the high vapor-phase carbon tetrachloride concentrations above the Plio-Pleistocene layer prior to remediation.

Within the vadose zone, carbon tetrachloride vapor may also flow in any direction along pressure gradients caused by barometric pressure fluctuations, which are damped and delayed as they propagate through the subsurface. The fluctuations are increasingly damped and delayed in the subsurface as the cumulative relative permeability of the overlying materials decreases. The pressure gradients may be vertical as a result of the pressure contrast between the subsurface and the surface or between soils above and below a lower permeability layer, or the pressure gradients may be horizontal between a location in the subsurface (e.g., open borehole) that communicates instantaneously with surface pressure changes and another location in the

subsurface that communicates more slowly through the interconnected pore space in the vadose zone (Rohay 1996). Because most boreholes in the 200 West Area are (or for many years were) capped but unsealed at the surface, each borehole has the potential to draw carbon tetrachloride vapors horizontally from the source area toward its open interval. Because most boreholes have no annular seal or have an annular seal designed to prevent water migration, the potential for vapor communication and transport also exists along the outside of the casing.

As the contaminated vapor moves into uncontaminated areas in the vadose zone, it may partition into the soil moisture and adsorbed phases. The carbon tetrachloride vapor may also provide a continuous source of contamination to groundwater. In the vadose zone, carbon tetrachloride vapors that equilibrate with perched water, with wastewater from other sources, and/or with infiltrating natural recharge water may then be transported to the water table in dissolved form. These aqueous transport mechanisms can also affect the soil moisture and adsorbed phases contaminated by vapor.

Carbon tetrachloride may volatilize from the dissolved groundwater plume. The contaminant vapors would then move upward by diffusion but may become temporarily trapped below the Plio-Pleistocene layer. The distribution of carbon tetrachloride vapor below the Plio-Pleistocene layer throughout much of the 200 West Area underlain by the groundwater plume suggests that these vapors may have volatilized from the dissolved groundwater plume throughout the 200 West Area.

Vapor transport, although still occurring, is expected to have been significantly reduced by removal of vapor since 1992 using SVE.

Older, poorly sealed wells, which penetrate either the Plio-Pleistocene unit and/or the water table, may provide a vertical conduit for fluids. Nonaqueous-phase liquid carbon tetrachloride, aqueous-phase dissolved carbon tetrachloride, and vapor-phase carbon tetrachloride that intercept the borehole in the subsurface may migrate downward along the outside casing of the well. In addition, these fluids may be channeled along natural preferential pathways, such as fractures, clastic dikes, and large, interconnected pores, within the vadose zone.

Migration of fluids, both liquid and vapor, are influenced by the natural stratification and variability of the sediments. The Plio-Pleistocene paleosurface is a relatively continuous, lower permeability barrier to vertical movement of fluids in the vadose zone. This layer most likely diverted carbon tetrachloride liquid and/or vapor laterally away from primary carbon tetrachloride disposal sites until a sufficient amount accumulated to force the liquid or vapor through the lower permeability layer (Rohay and Johnson 1991). The surface of the Plio-Pleistocene unit generally slopes toward the south from the primary carbon tetrachloride disposal sites (Rohay et al. 1994a). For example, DNAPL may have migrated from 216-Z-1A to the south toward the 216-Z-18 site, where carbon tetrachloride was detected during drilling of monitoring wells 299-W18-9, 299-W18-10, and 299-W18-11 in 1968, before the crib was placed into service. However, as mentioned earlier, recent work by the University of South Carolina (Waddell et al. 1999) would suggest that movement of DNAPL may have been to the north of the 216-Z-9 Trench. The character of the Plio-Pleistocene layer varies across the 200 West Area

and includes locally less-cemented, more permeable areas and fractures that allow more rapid fluid flow (Slate 1996).

Because of its low dielectric constant, carbon tetrachloride can theoretically increase the permeability of the subsurface materials and thereby strongly influence its own migration pathway. Solutions with high dielectric constants, such as water (Table G-8), will cause alumino-silicate clays to swell. A liquid with a low dielectric constant, such as carbon tetrachloride, causes clays to shrink and thereby increases the permeability of the soil through the introduction of cracks and fissures. Clay-sized particles that include alumino-silicate clay minerals occur throughout the vadose zone but are typically more abundant in the Plio-Pleistocene unit (Wright et al. 1994). Alumino-silicate clay minerals are also a component of the bentonite commonly used in annular seals for boreholes. However, permeation of water-wet clays (which describes nearly all subsurface clays) by aqueous solutions containing nonaqueous-phase chlorinated solvents at concentrations at or below their solubility limits does not influence the permeability of clays because the low concentrations of these organic chemicals do not decrease the dielectric constant of the aqueous solution sufficiently (Pankow and Cherry 1996). Furthermore, nonaqueous-phase organic liquids apparently do not chemically increase the permeability of water-wet clay soils through changes to intracrystalline swelling because (1) the flow of the nonaqueous-phase liquid is restricted to pre-existing macro-pores or fractures in the clay, (2) the film of water separating the organic liquid and the clay surface prevents the organic liquid from contacting or entering the clay other than in dissolved form, and (3) the solubility of the nonaqueous-phase liquid is too low to significantly affect the dielectric constant of the water (Pankow and Cherry 1996). Based on the evaluation presented in Pankow and Cherry (1996), it appears that exposure to nonaqueous-phase liquids is unlikely to cause permeability increases in natural clay-rich soils. And if such chemically induced increases did occur, the confining stresses due to the overburden would likely cause compaction of the clay-rich layer, preventing the increase in permeability (Pankow and Cherry 1996).

Carbon tetrachloride may become “irreversibly” adsorbed within intraparticle sediment pore spaces. Intraparticle porosity refers to the very small pores and associated surfaces within a particle of soil. Intraparticle pore sizes range from macropores (pores with diameters greater than 500 Å) to micropores (cylindrical or slit-shaped pores with diameters less than 20 Å) (Yonge et al. 1996). As summarized by Yonge et al. (1996), Farrell and Reinhard (1994) have demonstrated that adsorption in micropores contributes significantly to sorbate uptake and contributes to isotherm nonlinearity on solids with low natural organic matter. They further note that hysteresis between adsorption and desorption may result from the fact that the nature of the micro-environment has been changed due to the initial adsorption. They state that the rate of desorption from soils with a high amount of intraparticle porosity is controlled by desorption from the intraparticle spaces, and once external contaminant is removed, the internal contaminant may require months or even years to desorb completely. Because the approximate molecular diameter of carbon tetrachloride is 5 Å, it would have access to micropores (Yonge et al. 1996). The adsorption of carbon tetrachloride would be higher in the silty sands, which have a significantly higher amount of surface area than the sands (Ford 1996). The adsorption of carbon tetrachloride would also increase with time (Wilson et al. 1994).

Based on laboratory studies using carbon tetrachloride and site-specific soils, Yonge et al. (1996) estimated that SVE can remove only 10% to 15% of the initial mass of carbon tetrachloride (excluding any nonaqueous liquid phases) in contaminated zones through which flow is passing directly. Based on laboratory testing where carbon tetrachloride removal was dictated by diffusion from a zero velocity field to areas where flow was occurring, they describe four phases in the concentration-time profile: initial pore gas evacuation, free product removal, vapor diffusion from low-velocity fields (transitional phase) and, finally, desorption-controlled removal (tailing phase). In field situations, which involve a complex heterogeneous subsurface, Yonge et al. (1996) expect that a relatively rapid concentration decrease followed by at least one slower rate of concentration decrease would be observed. They point out that when the rate of decrease reaches an asymptotic level and the contaminant collection yield reaches a perceived minimum, higher flows will probably not enhance removal. This is the region of removal controlled by desorption kinetics, and Yonge et al. (1996) conclude, based on their study, that even though a relatively high-concentration gradient exists with regard to known adsorption characteristics, mass transfer is extremely slow (Yonge et al. 1996). Based on the carbon tetrachloride SVE and rebound data, Cameron (1997) believes that most of the vapor extraction site has passed through the first two phases and that some of the site is in the transitional phase and some is in the tailing phase.

G.4.3 Vadose Zone/Groundwater Interface

The capillary fringe forms the interface between the vadose and groundwater zones. Because the capillary fringe does not contain a connected gas phase, transport of contaminants through this zone must occur in the aqueous or DNAPL phase. The three main mechanisms for aqueous contaminant migration through the capillary fringe are diffusion and dispersion, advection, and fluctuations in the elevation of the water table (Pankow and Cherry 1996). These processes of aqueous-phase transport would produce a shallow groundwater plume (Pankow and Cherry 1996).

At the top of the capillary fringe, vapor-phase contaminants partition into the aqueous phase, and transport through the capillary fringe occurs by dispersion and diffusion along the aqueous-phase concentration gradient (Pankow and Cherry 1996). A vapor-phase source should result in a shallow (1- to 2-m thick) vertical distribution in the aquifer due to the relatively slow process of molecular diffusion, the process by which the carbon tetrachloride vapor enters the groundwater (Pinder and Abriola 1986). Pankow and Cherry (1996) point out that because molecular diffusion and dispersion are weak processes, advective transport due to infiltrating water is likely to be a more significant mechanism for transporting contaminants downward through the capillary fringe. At the carbon tetrachloride disposal sites, an infiltrating water mechanism would have been more viable during operations when large volumes of water were artificially recharging the groundwater.

The elevation of the water table can change in response to barometric pressure fluctuations, regional water table decline, and pump-and-treat operations. Each of these may influence carbon tetrachloride migration. The water table below the carbon tetrachloride source cribs fluctuates daily in response to barometric pressure fluctuations. Over a 20-year period (1965-1985), the elevation of the water table rose and then declined 2 m; it is currently declining 0.43 m/yr

(DOE-RL 2001). As the water table drops, contaminated vapors are drawn deeper into the expanded vadose zone and can partition into the newly exposed soil moisture. When the water table rises, the contaminated soil moisture will be incorporated into the groundwater system (Pankow and Cherry 1996). At the carbon tetrachloride site, the 2-m rise from 1965 to 1977 probably incorporated the carbon tetrachloride in that zone. The gradual but continual water table decline since 1977 would minimize additional contamination of the groundwater, but the daily fluctuations create a mixing zone that may continue to incorporate carbon tetrachloride. Temporary cessation of pump-and-treat operations at individual extraction wells would cause the water table to rise locally, incorporating carbon tetrachloride that migrated downward into the cone of depression. However, cessation of operations occurs infrequently, and this mechanism may be insignificant with respect to degradation of groundwater quality. This mechanism seems an unlikely explanation of the increased concentrations observed at extraction well 299-W15-32 following temporary shutdown in 1999, as described previously. In that case, the increase in concentrations at the well appeared to be delayed, whereas the drawdown of newly contaminated water would probably be “instantaneous.”

Transport and partitioning of carbon tetrachloride vapor between the groundwater and vadose zone may contribute to the large “low-concentration halo” surrounding the high-concentration core of the groundwater plume.

As a DNAPL moves into the tension-saturated portion of the capillary zone, it must displace water if continued downward migration is to occur. Because it is generally a nonwetting fluid with respect to water, there must be a sufficient buildup of capillary pressure to allow the organic liquid to overcome the entry pressure of the nearly water-saturated medium (Pankow and Cherry 1996). DNAPL may also spread laterally at the top of the capillary fringe. DNAPL that reached the 216-Z-9 capillary fringe prior to 1965 was probably incorporated into the groundwater by the rise of the water table between 1965 and 1977.

Potentially, a continuing source of carbon tetrachloride to the groundwater in the area below the 216-Z-9 site exists because the centroid of the groundwater plume still includes the area underlying the disposal sites. The carbon tetrachloride source may be within the vadose zone and/or within the aquifer. Numerical modeling of vadose zone flow and transport indicates that both dissolved and nonaqueous-phase carbon tetrachloride reached the groundwater beneath the 216-Z-9 Crib and may have continued to enter the aquifer for many years. This potential vadose zone source is being mitigated by SVE operations that began in 1992.

Carbon tetrachloride concentrations monitored in the deep soil vapor and in underlying groundwater in the 216-Z-9 area since 1997 do not appear to be in equilibrium, and the expected direction of carbon tetrachloride migration is from the groundwater to the vadose zone (Rohay 1997).

G.4.4 Groundwater

Numerical modeling of carbon tetrachloride flow and transport in the vadose zone indicates that the depth of penetration of carbon tetrachloride (dissolved and nonaqueous phases) into the aquifer depends on the residual saturation in the vadose zone, which affects the flux to the

aquifer, and the groundwater flow rate, which affects the lateral to vertical flux within the aquifer (Piepho 1996). For the higher value of residual saturation (0.01) used in the modeling, dissolved carbon tetrachloride reached approximately 20 m below the water table and nonaqueous-phase carbon tetrachloride reached approximately 10 m below the water table. For the lower value of residual saturation (0.0001) used in the modeling, dissolved carbon tetrachloride reached approximately 50 m below the water table and nonaqueous-phase carbon tetrachloride reached approximately 25 m below the water table. (Note: The nonaqueous-phase case for a residual saturation of 0.0001 was not shown in Piepho [1996]; the 25-m depth was estimated by analogy to higher residual saturation case.)

Preliminary sitewide numerical modeling of carbon tetrachloride transport in the aquifer indicates that under nonretarded flow conditions, contaminant concentrations in excess of 5 $\mu\text{g/L}$ will move significantly past the 200 East Area perimeter in 200 years with or without the current remediation activities (i.e., the pump-and-treat interim remedial measure does not affect the overall size and extent of the diffuse plume) (Chiaramonte et al. 1997). However, if a small retardation factor is included in the analysis, the movement of carbon tetrachloride will be significantly slowed, just reaching the eastern border of 200 East Area in 200 years. The extent of contamination is very sensitive to the carbon tetrachloride partitioning coefficient between the aquifer sediments and groundwater. Values for the partitioning coefficient are not well defined for Hanford sediments. Other important factors that this modeling effort did not take into account were biodegradation, abiotic degradation, and volatilization of carbon tetrachloride during transport. These factors may reduce the extent of contamination over any comparable period of time. Another modeling effort, using an accepted sitewide groundwater model, should be performed to account for these other factors, and predict the future extent, geometry, and concentrations of carbon tetrachloride. Such a modeling effort will be necessary to support a final remedy selection and risk analysis.

Partitioning of carbon tetrachloride to aquifer sediments is assumed to be low (or zero) and may be variable across the site. Site-specific measurements of the partitioning coefficient magnitude and spatial distribution have not been published. However, a distribution coefficient (K_d) of 0.0 to 0.2 mL/g was suggested as likely for carbon tetrachloride aqueous solutions on Hanford Site soil based on batch K_d experiments (Last and Rohay 1993). A literature estimate for soil distribution of carbon tetrachloride is 0.114 mL/g (Chiaramonte et al. 1997). To calculate the inventory of carbon tetrachloride sorbed to vadose zone soils in 1990, a K_d value of 0.192 mL/g was estimated using the method of Thibodeaux et al. (1990) (WHC 1993). This K_d value falls within the range discussed for partitioning of carbon tetrachloride to aquifer sediments.

More recently, as part of an innovative treatment remedial demonstration for carbon tetrachloride, Truex et al. (2001) conducted a review of current published literature on potential natural attenuation processes that could affect the concentration of carbon tetrachloride. In the literature review, Truex et al. examined the K_d and abiotic half-lives for carbon tetrachloride. The most probable value of K_d for the Hanford Site aquifer was estimated at 0.12 L/kg. For abiotic transformation of carbon tetrachloride, the range of reported half-lives was found to be 40 to 7,000 years. Because these factors could have a significant effect on migration and concentrations of carbon tetrachloride, additional laboratory or in situ tests on Hanford Site sediments are recommended. Test results will support future predictive modeling and analytical

evaluation of carbon tetrachloride concentrations. The estimated K_d value of 0.12 L/kg is similar to the 0.114 L/kg used in the previous modeling study by Chiaramonte et al. (1997).

Pump-and-treat extraction and injection operations have affected the distribution and concentrations of carbon tetrachloride in the centroid portion of the plume. The $>4,000\text{-}\mu\text{g/L}$ contour interval has expanded in size and now extends more northerly and easterly to near the extraction wells, although it may be slightly reduced in the southwest (Figure G-3). Injection of treated groundwater at the upgradient location is beginning to dilute the carbon tetrachloride plume in this area. The increase in size of the $4,000\text{-}\mu\text{g/L}$ contour and the steady or increasing concentrations in the interior wells may imply more than just aqueous-phase movement (dissolved carbon tetrachloride) toward the extraction wells, e.g., the presence of DNAPL, residual carbon tetrachloride, or a higher partitioning coefficient than previously estimated. Approximately 4,570 kg of carbon tetrachloride have already been removed with only slight reductions in concentrations in the high-concentration area. Therefore, the mass of carbon tetrachloride within the treatment area may be greater or distributed differently than what was assumed prior to pump-and-treat remediation.

G.5 ORGANIC CO-CONTAMINANTS

The ratio of chloroform (a carbon tetrachloride biodegradation breakdown product) to carbon tetrachloride concentrations in vapor extracted using the SVE system is linear (Figure 5-30). For carbon tetrachloride concentrations greater than 1,000 ppmv, chloroform concentrations are approximately 0.005 that of carbon tetrachloride concentrations.

The 1989 Essential Material Specification for carbon tetrachloride states that the carbon tetrachloride must be 99% pure. Based on the process used to manufacture carbon tetrachloride, it is believed that the carbon tetrachloride used earlier in Z Plant operations was also relatively pure. The other 1% would typically be long-chain alcohols used by industry as additives to prevent light degradation of the product.

The transport and inventory partitioning estimates presented in this discussion have been made using pure liquid-phase carbon tetrachloride properties. However, the carbon tetrachloride was not discharged as a pure liquid but as a mixture with other organics (TBP, DBBP, and lard oil). The liquid properties (density, viscosity, interfacial tension, and vapor pressure) of three representative mixtures, 85:15 carbon tetrachloride:TBP, 50:50 carbon tetrachloride:DBBP, and 50:50 carbon tetrachloride:lard oil, are presented in Table G-8. The organic composites (even the carbon tetrachloride:lard oil mixture) were found to be denser and more viscous than water (Last and Rohay 1993). Vapor pressure of the carbon tetrachloride:DBBP and carbon tetrachloride:lard oil mixtures is only half that of the pure carbon tetrachloride and the carbon tetrachloride:TBP mixture. The interfacial tension between the 50:50 carbon tetrachloride:lard oil mixture and a 5 M sodium nitrate solution was found to be low, suggesting that the fluids may be somewhat miscible, allowing them to mix and behave more as an aqueous fluid (Last and Rohay 1993).

An 85:15 carbon tetrachloride:TBP ratio was used to make up the organic solution used in the plutonium recovery process. However, with exposure to ionizing radiation and nitric acid, the TBP within the solvent would gradually degrade to DBP. DBP has a much greater affinity for plutonium than TBP and would not work in the process because of its poor stripping properties. It was the degraded solvent that was discharged to the soil column.

The major organic co-contaminants TBP, DBP, and DBBP associated with the carbon tetrachloride solvent waste streams were not analyzed in groundwater samples collected during the 1991 characterization activities. However, existing data for TBP and DBP acquired for other programs between 1987 and 1990 are available. Results for samples from several wells in the vicinity of the Z cribs, as well as from wells within the core of the 200 West Area carbon tetrachloride plume, were all below detection limits for TBP and DBP. DBBP has not been previously analyzed. The apparent absence of TBP and DBP in 200 West Area groundwater is attributed to biodegradation of these organic constituents and/or because they have a moderate affinity for sediments (Ames and Serne 1991, Rohay and Johnson 1991). Soil and groundwater samples collected during drilling in 1992 were analyzed for TBP. TBP was detected in only one sample from the vadose zone (well 299-W15-217, 24.6-m depth), and the result was below the limit of quantitation (Rohay et al. 1994a). Analyses for DBP and DBBP were not conducted. The lack of TBP in vadose soils suggests that TBP degrades relatively quickly. The lack of TBP detected in groundwater suggests that carbon tetrachloride might have been a relatively pure phase when it reached groundwater. However, the differential partitioning and biodegradation of the components of these organic mixtures in Hanford Site sediments has not been determined.

Vadose zone sampling of soil and soil vapor in the source area has also detected methylene chloride, chloroform, TCE, tetrachloroethylene (PCE), trans-1,2-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, benzenes, xylenes, and toluene (Rohay et al. 1994a).

Groundwater sampling within and beyond the source area has also detected chloroform, methylene chloride, TCE, and PCE (Rohay et al. 1994a, DOE-RL 1999b).

PCE and tetrabromoethane were used at different times in combination with carbon tetrachloride as a diluent for TBP or for cleaning agents (Smith 1973, with respect to the wastes discharged to 216-Z-9).

Nitrate in the aqueous wastes discharged to the carbon tetrachloride source cribs has also produced an extensive groundwater plume (Figure G-4). Because nitrate and carbon tetrachloride were co-contaminants in the aqueous-phase discharges, comparison of the distribution of the two groundwater plumes may help in understanding the major factors affecting plume movement. For example, although the K_d for carbon tetrachloride is not well known, the K_d for nitrate is known to be zero (i.e., nitrate is not retarded in groundwater). The maximum extent of the carbon tetrachloride (defined by the 5- $\mu\text{g/L}$ contour) and nitrate (defined by the 20-mg/L contour) plumes is similar to the north and northeast of the Z Plant area, suggesting that carbon tetrachloride has behaved as a nonretarded contaminant in groundwater (Figures G-3 and G-5). The absence of nitrate and presence of carbon tetrachloride to the

southwest of the former U Pond site suggests that the carbon tetrachloride lobe is not a result of southerly flow during the initial period of discharge.

G.6 DATA GAPS

The nature and extent of the carbon tetrachloride plume have been partially defined, but several key data gaps currently exist. The data gaps are identified in this report to help describe some uncertainties in the existing database being used to formulate the conceptual model.

1. The nature and magnitude of the exchange of carbon tetrachloride between the vadose zone and groundwater needs to be investigated. This information will be required in the future to address the interdependency of the vadose zone-groundwater system in achieving remediation of the 200 West Area subsurface carbon tetrachloride contamination. The study, including field measurements near the groundwater-vadose zone interface, should be undertaken to quantify the volatilization process.
2. The lateral extent of the carbon tetrachloride plume in the vadose zone and vertical extent of the carbon tetrachloride plume in the groundwater need to be better defined. These data would help define the extent of the contamination and therefore the expected magnitude of the remediation efforts.
3. The location, amount, and properties of DNAPL carbon tetrachloride within the subsurface need to be quantified. This information would help focus and define the remediation needs.
4. The residual saturation of carbon tetrachloride needs to be quantified (i.e., the carbon tetrachloride held in vadose zone sediments that is no longer mobile except through partitioning to pore water that is still migrating). This information would help account for inventory between the vadose and groundwater zones, help refine the estimates of flux from the vadose zone to the groundwater, and help refine the numerical modeling estimates of the depth of carbon tetrachloride in the aquifer. Because SVE operations have modified the distribution of subsurface carbon tetrachloride and possibly soil moisture beneath the disposal sites, part of this task would be identification of suitable locations for data collection and measurements.
5. Data are needed to determine the extent of the nonequilibrium sorption in the vadose zone and groundwater. This information would help account for the inventory, support modeling work, and help define remediation needs.
6. The partitioning coefficient (K_d) for carbon tetrachloride on site sediments and its variation across the site needs to be quantified. For example, the literature search by Truex et al. (2001) revealed that the K_d can vary significantly. This information would help refine the predictions of carbon tetrachloride transport rates using numerical models.

7. The interaction between carbon tetrachloride and calcium carbonate needs to be quantified. This information would help determine carbon tetrachloride transport mechanisms and rates through the Plio-Pleistocene unit.
8. The abiotic half-life of carbon tetrachloride under site conditions needs to be quantified. The potential degradation of carbon tetrachloride may contribute to natural attenuation of the plume and could be a significant term in the assessment of the carbon tetrachloride mass balance.
9. The inventory mass balance should be reevaluated based on more recent studies and data from current remedial actions in the groundwater and the vadose zone. The existing evaluation of the mass balance was based on 1990 groundwater plume data for the upper 10 m of the aquifer and limited soil vapor data. This information would help define the source term.
10. The hydraulic flow fields during and after the carbon tetrachloride disposal should be reevaluated to determine if the distribution of the relatively high concentrations of carbon tetrachloride to the northwest, the low-concentration lobes of carbon tetrachloride to the south, and the concentrations of carbon tetrachloride near T Plant are reasonable based on the hydraulics alone. Results of this evaluation potentially may identify other contributing carbon tetrachloride disposal areas.
11. A systematic study of the carbon tetrachloride/chloroform relationship in both the vadose zone and groundwater should be conducted using existing data. Understanding the cause and significance of the variation in the ratio of carbon tetrachloride to chloroform could potentially yield insights on contaminant source, inventory, distribution, and persistence of the chloroform plume. This study could be extended to include the full carbon tetrachloride degradation chain to support evaluation of natural attenuation.
12. A predictive modeling effort needs to be performed that considers the fate and transport of carbon tetrachloride over the next several hundred years. Such a model is needed to account for all of the significant factors that affect the migration and concentration of carbon tetrachloride and ultimately will be needed to support final remediation decisions.
13. Numerical modeling of carbon tetrachloride migration in the vadose zone is needed that incorporates the effects of three-dimensional stratigraphy and heterogeneities, multi-phase flow, and co-contaminants. This model could help guide characterization and remediation efforts in vadose zone and groundwater and support selection of remedial alternatives.

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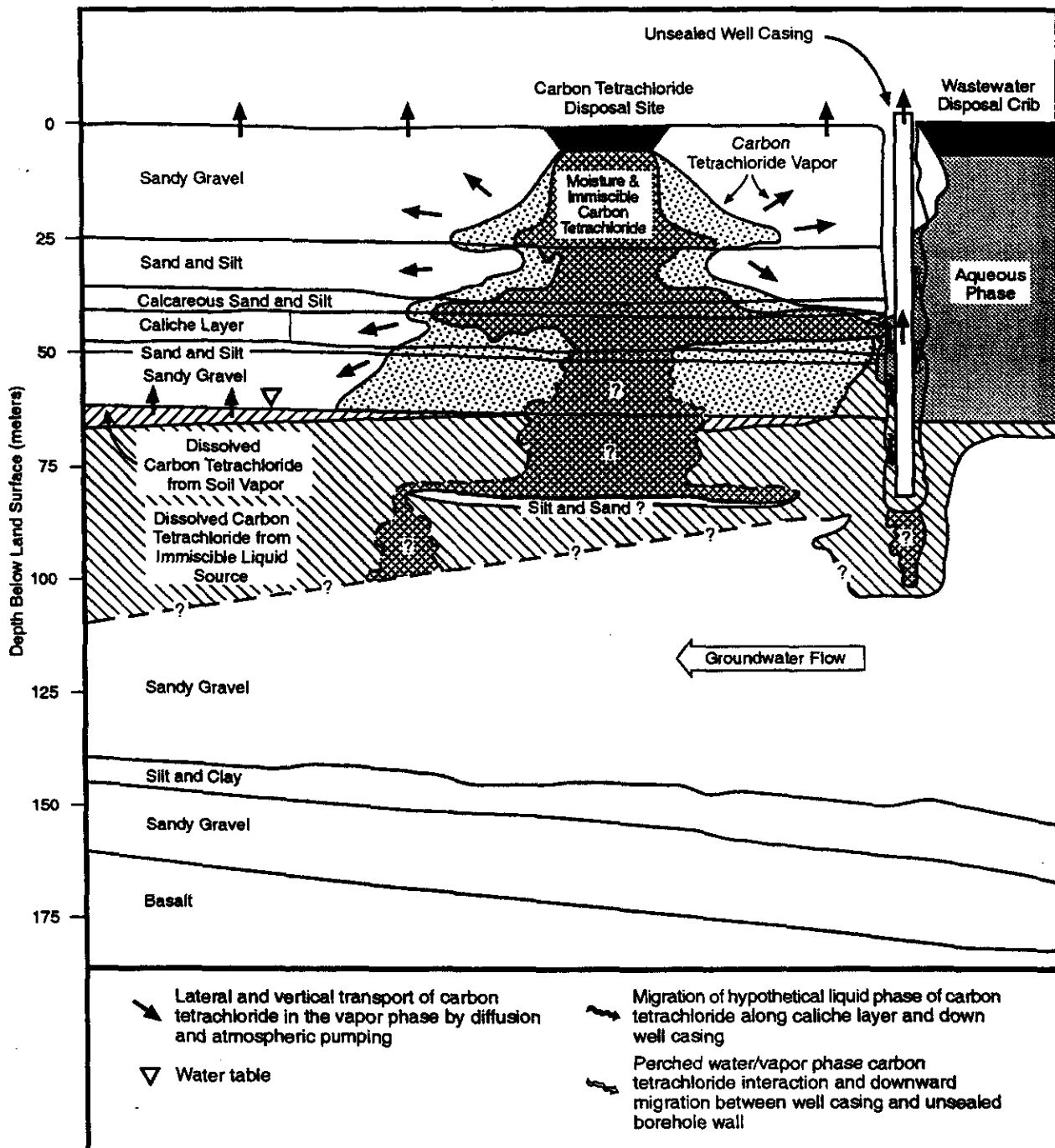
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Figure G-1. Schematic Illustration of Carbon Tetrachloride and Wastewater Migration Beneath the 216-Z-9 Trench in the Higher Concentration Portion of the Plume.



E9906104.4

Map of the Savannah River Site showing environmental monitoring wells, buildings, and fences. The map includes labels for various wells (e.g., 216-T-1, 216-U-1), buildings (e.g., 216-S-10, 216-S-11), and fences. A legend in the bottom right corner defines symbols for buildings, waste sites, roads, fences, carbon tetrachloride, and monitoring wells. A scale bar at the bottom right indicates distances in feet (0 to 2400) and meters (0 to 800).

200-ZP-1
Carbon Tetrachloride Plume
June 1996 to July/August 2000

○ Monitoring Well
 ▲ Extraction Well
 ▼ Injection Well
 "W" wells prefixed by 299-
 "X" denotes dry well

Carbon Tetrachloride
 Concentration µg/L
 (July/August 2000)
 Carbon Tetrachloride
 Concentration µg/L
 (June 1996)

Elevation Datum NAVD88

METERS
 0 100 200

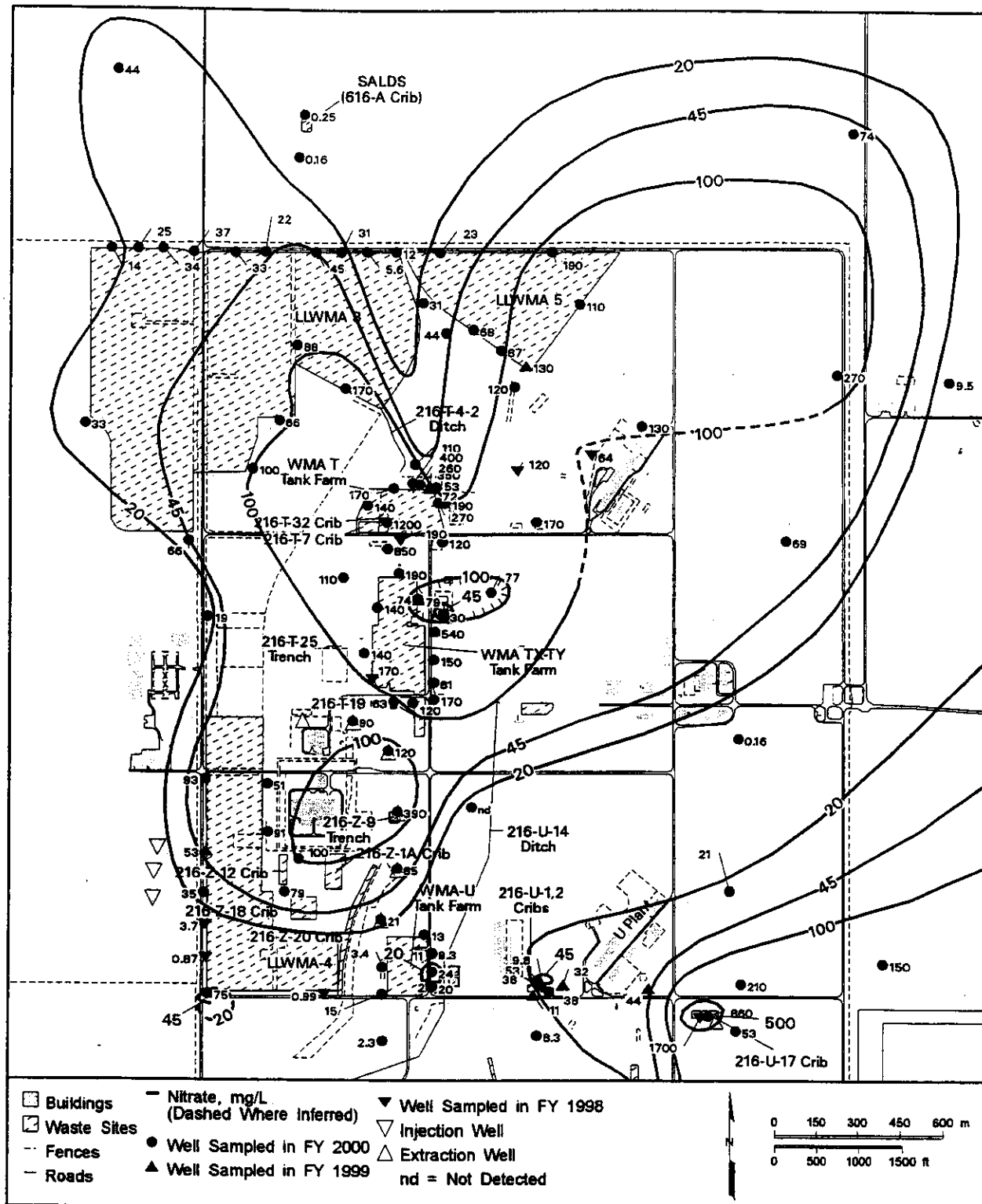
19TH STREET
 20TH STREET
 CAMDEN AVENUE
 DAYTON AVENUE

TX Tank Farm (241-TX)
 Air Stripper Pad
 Treatment Building
 PFP
 216-Z-12 Crib
 216-Z-1A Tile Field
 216-Z-18 Crib
 216-Z-19 Ditch and 216-Z-20 Crib
 U Tank Farm (241-U)

W15-1 to W19-31
 W18-23 to W18-39
 W18-29, W18-36, W18-37, W18-38, W18-39

1000, 4000, 6000 µg/L contours

Figure G-4. Average Nitrate Concentrations in the 200 West Area
(from Hartman et al. 2001).



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Figure G-5. Decreasing Carbon Tetrachloride Concentrations at
Extraction Well 299-W15-32, Located Next to the 216-Z-9 Trench.

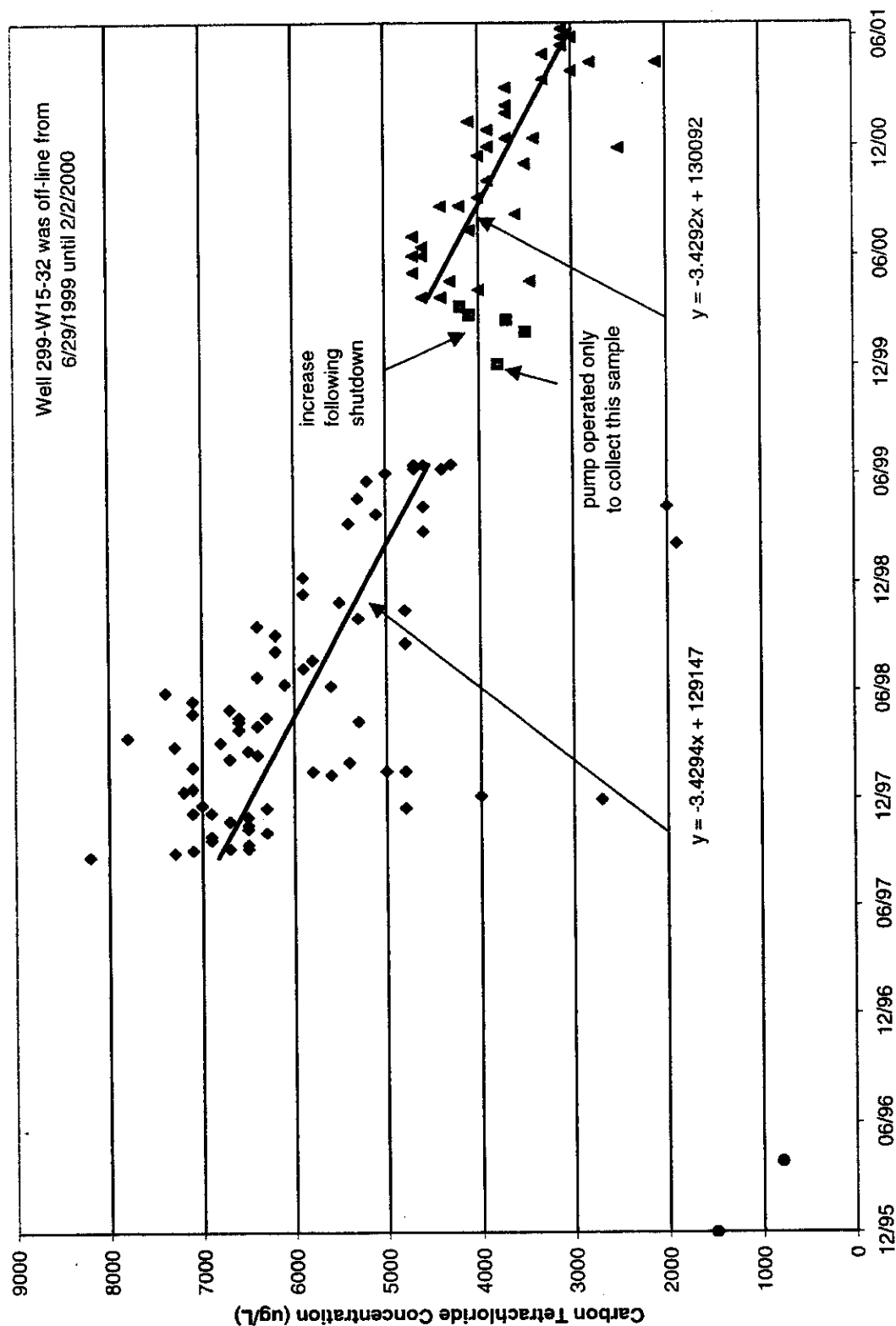


Figure G-6. Hydrographs for Four TX-TY Tank Farm Wells.

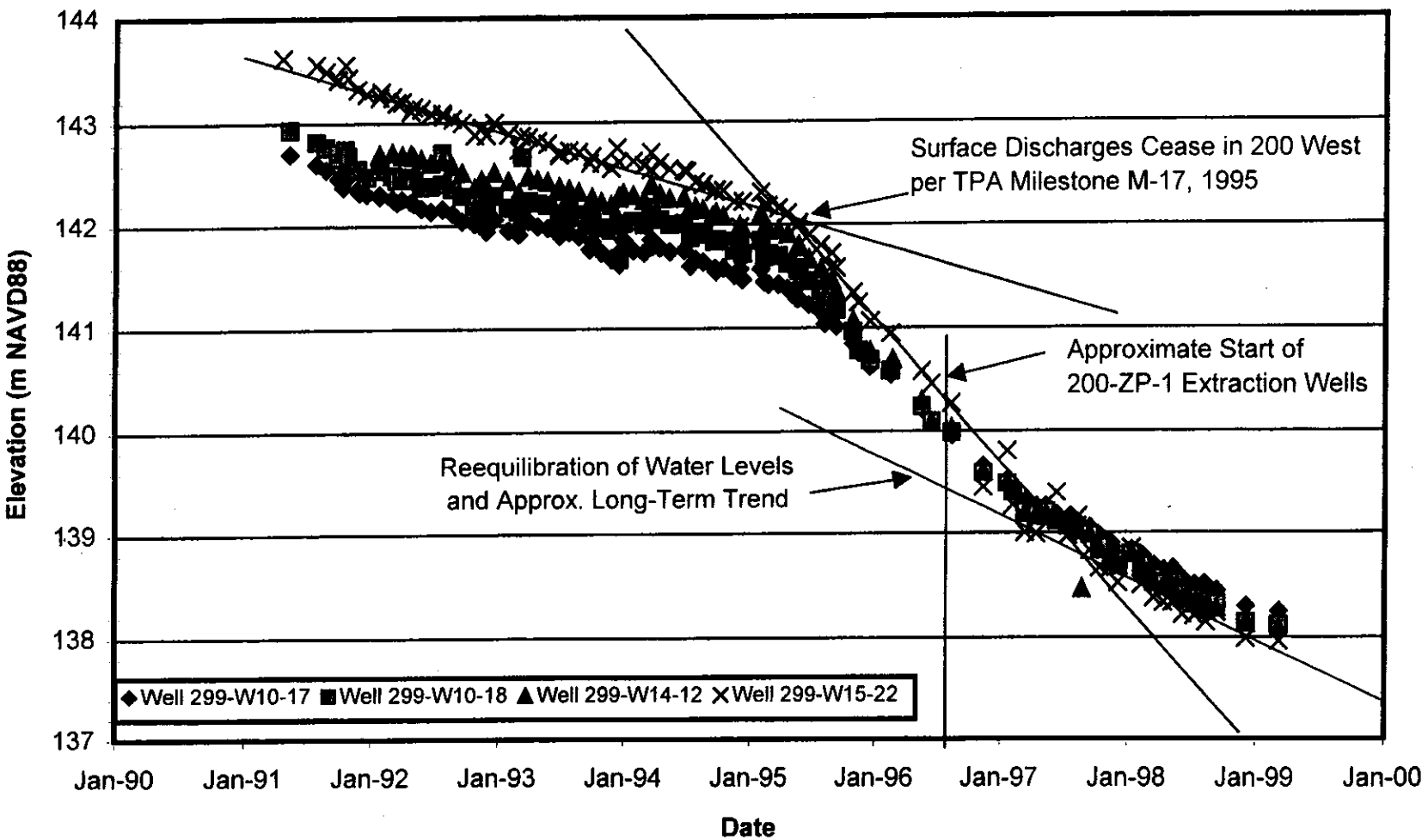
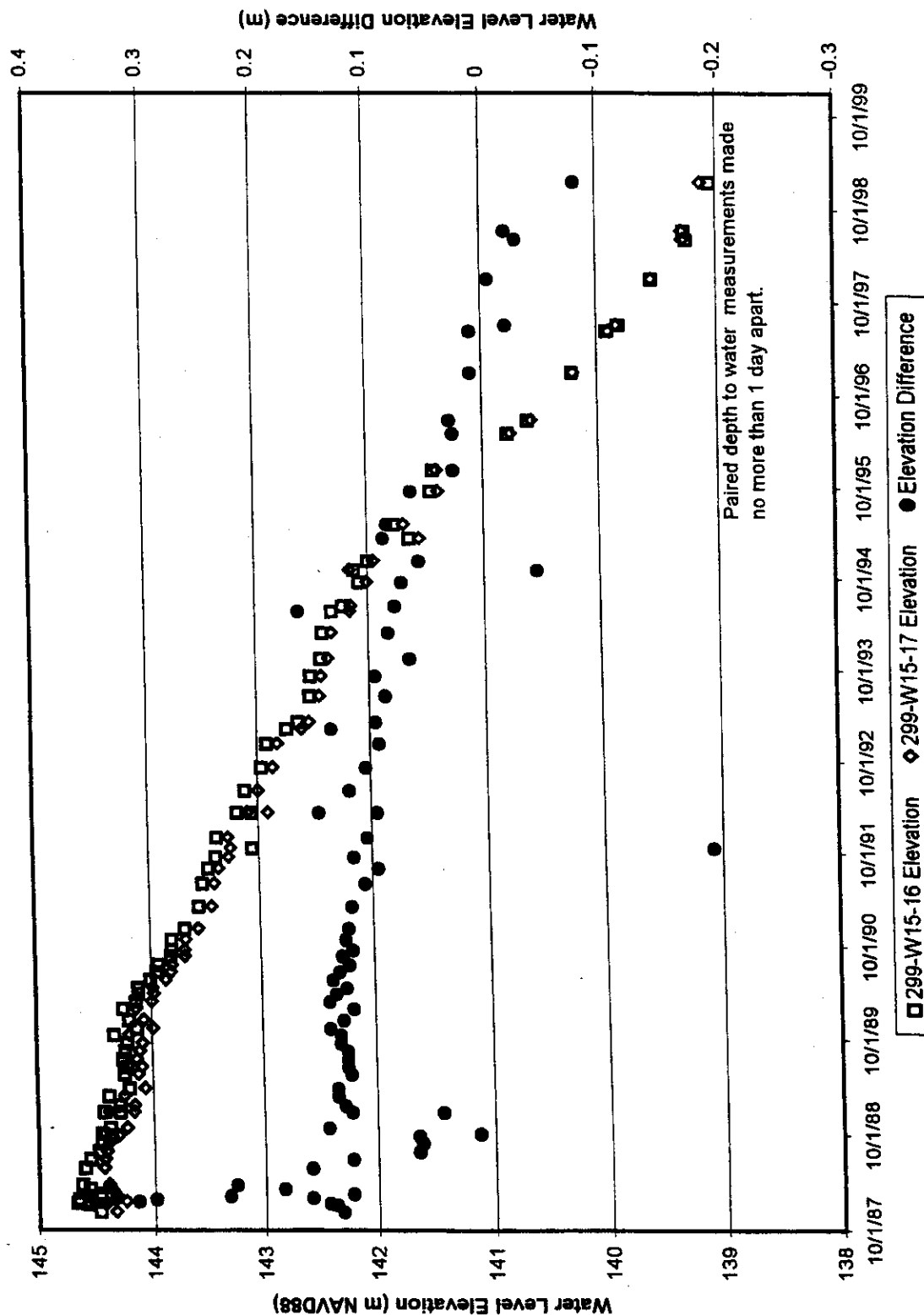


Figure G-7. Difference in Water Level Elevation Between
Wells 299-W15-16 and 299-W15-17.



**Appendix G – 1999 Carbon Tetrachloride
Conceptual Model Update**

BHI-00720

Rev. 5

Table G-1. Waste Constituent Inventory Summary for the Three Primary Carbon Tetrachloride Disposal Facilities (from Rohay et al. 1994a).

Facility	Operating Dates	Total Volume (L)	Plutonium (kg)	Americium (kg)	Carbon Tetrachloride (kg)	Carbon Tetrachloride (L)	TBP (L)	DBBP (L)	Lard Oil (L)
216-Z-9	1955 to 1962 ^a	4.09E+06	106 ^c	2.5	130,000 – 480,000	83,000 – 300,000	27,900	46,500	9,300
216-Z-1A	1949 to 1959 ^b	1.00E+06	0.05	ND	ND	ND	ND	ND	ND
	1964 to 1969	5.20E+06	57	1	270,000	170,000	23,900	27,500	11,000
216-Z-18	1969 to 1973	3.86E+06	23	0.4 ^d	170,000	110,000	16,400	19,100	ND
Total	1955 to 1973	1.42E+07	186 ^c	3.9	570,000 – 920,000	363,000 – 580,000	68,200	93,100	20,300

^aThe Recuplex operation that used carbon tetrachloride was discontinued after a criticality incident in April 1962 and was replaced in 1964 by the Plutonium Reclamation Facility (DOE-RL 1991).

^bFrom 1949 to 1959, the 216-Z-1A Tile Field received slightly basic, aqueous waste via overflow from associated 216-Z-1, -2, and -3 cribs prior to disposal of carbon tetrachloride waste (Price et al. 1979). From 1964 to 1969, carbon tetrachloride wastes were discharged directly to 216-Z-1A.

^c58 kg were later removed (Ludowise 1978).

^dBased on ratio of 1 kg americium to 57 kg plutonium for 216-Z-1A.

DBBP = dibutyl butyl phosphonate

ND = no available data

TBP = tributyl phosphate

**Table G-2. General Characteristics of the Vadose Zone Underlying the
Carbon Tetrachloride Disposal Sites.**

Geologic Unit	Geologic Material	Depth (m below ground surface)	Thickness (m)	Intrinsic Permeability (m ²) ^a	Field Moisture Content ^b (vol%)	Air Conductivity ^a (m/day)	Equivalent Hydraulic Conductivity ^a (m/day)
Hanford upper fine (H _{uf})	Gravelly sand and sand	0 – 6	6	1.6 E-11	5.5	1	9.0
Hanford upper coarse (H _{uc})	Gravel	6 – 16	10	4.1 E-10	4.6 – 5.7	25	231.4
Hanford fine (H _f)	Sand	16 – 31	15	1.6 E-11	1.5 – 19.7	1	9.0
Hanford lower coarse (H _{lc}) ^c	Sandy gravel	31 – 34	3	3.3 E-10	5.1 – 5.3	20	186.3
Hanford lower fine (H _{lf}) ^c	Interbedded silt and fine sand	34 – 38	4	1.6 E-12	6.1 – 11.8	0.1	0.9
Plio-Pleistocene (P-P)	Fine sandy silt/ carbonate- cemented sandy gravel ("caliche")	38 – 45	7	8.2 E-13	8.1 – 38.5	0.05	0.5
Ringold Unit E (R _{ge})	Gravel	45 – 66	21	1.3 E-10	3.4 – 17.6	8	73.4

^aCalibrated values based on numerical airflow model (Rohay and McMahon 1996).

^bBased on samples collected during drilling at the carbon tetrachloride sites in 1992 and 1993 (Wright et al. 1994).

^cNot present underlying the 216-Z-9 Trench.

**Table G-3. Configuration of the Plio-Pleistocene Unit Underlying the
Carbon Tetrachloride Disposal Sites.**

Plio-Pleistocene Unit	216-Z-9 Site	216-Z-1A/Z-18/ Z-12 Site	Both Sites
Minimum depth to top ^a (m bgs)	31	36	--
Maximum depth to top ^a (m bgs)	35	45	--
Average depth to top ^a (m bgs)	34	39	38
Minimum depth to bottom ^a (m bgs)	35	42	--
Maximum depth to bottom ^a (m bgs)	45	54	--
Average depth to bottom ^a (m bgs)	38	48	45
Minimum thickness ^b (m)	2	4	--
Maximum thickness ^b (m)	6	11	--
Average thickness ^b (m)	4	7	6

^aBased on 11 wells at 216-Z-9 and 42 wells at 216-Z-1A/Z-18/Z-12.

^bBased on 8 wells at 216-Z-9 and 18 wells at 216-Z-1A/Z-18/Z-12.

Table G-4. Disposition of Carbon Tetrachloride Inventory Discharged to the Soil Column.

Carbon Tetrachloride Disposition	Percent of Estimated Original Carbon Tetrachloride Inventory (Average 750,000 kg)	Estimated Mass of Carbon Tetrachloride (kg)	Reference
Estimated using pre-remediation data			
Equilibrium partitioning within vadose zone into vapor, dissolved, and adsorbed phases	12	91,000	WHC 1993
Lost to atmosphere	21	159,000	WHC 1993
Biodegraded	1	8,000 (4,385 for Z-9 only)	Hooker et al. 1996
Dissolved in upper 10 m of unconfined aquifer (assuming 30% porosity and no partitioning to aquifer solids)	1-2	5,250 – 15,740	Rohay and Johnson 1991
DNAPL/residual in vadose and/or unconfined aquifer	65	484,000	WHC 1993
Measured using remediation data			
Removed from vadose zone using soil vapor extraction (FY1991-FY2000)	10	76,500	Table 4-1
Removed from unconfined aquifer using pump and treat (200-ZP-1 and 200-UP-1 operations) (FY1994-FY2000)	0.6	4,600	DOE-RL 2001

Table G-5a. Mass Estimate of Carbon Tetrachloride Contained in Groundwater Plume in 1990 (from Rohay and Johnson 1991).

Contour Interval (µg/L)	Area (m ²)	Median Concentration (µg/L)	Calculated Mass (kg) ^a		Percent of Total	Cumulative Percent
			Porosity = 10%	Porosity = 30%		
10-100	8.34 E+06	55	460	1,380	8.75	8.75
100-1,000	3.09 E+06	550	1,700	5,100	32.39	41.14
1,000-2,000	0.64 E+06	1,500	970	2,900	18.44	59.58
2,000-3,000	0.30 E+06	2,500	760	2,280	14.49	74.07
>3,000	0.27 E+06	5,000	1,360	4,080	25.93	100.00
Total	12.65 E+06		5,250	15,740	100.00	

^aAssuming a depth of 10 m.

Table G-5b. Mass Estimate of Carbon Tetrachloride Contained in Groundwater Plume in 1996 (from Koepler 1997).

Contour Interval (µg/L)	Volume (m ³) ^a	Average Aqueous Concentration (µg/L)	Aquifer Mass			Sorbed Mass for K _d = 0.05 L/mg (kg) ^b	Sorbed Mass for K _d = 0.114 L/mg (kg) ^b
			kg ^b	Percent of Total	Cumulative Percent		
5 - 100	19,462,500	38.45	748	6.13	6.13	227	518
100 - 250	8,647,500	157.74	1,364	11.18	17.31	414	943
250 - 500	5,092,500	357.40	1,820	14.91	32.22	552	1,259
500 - 750	2,700,000	615.44	1,662	13.62	45.84	504	1,149
750 - 1,000	1,860,000	868.65	1,616	13.24	59.08	490	1,117
1,000 - 1,250	1,275,000	1092.70	1,393	11.42	70.50	423	964
1,250 - 2,000	832,500	1554.88	1,294	10.60	81.10	3,93	895
2,000 - 3,000	330,000	2452.79	809	6.63	87.73	246	560
3,000 - 4,000	232,500	3527.29	820	6.72	94.45	249	567
> 4,000	157,500	4299.37	677	5.55	100.00	205	468
Total	40,590,000	--	12203	100.00	--	3406	8440

^aAssuming a depth of 10 m

^bAssuming a porosity of 30%.

Table G-6. Pore Column Volume Estimates for the Carbon Tetrachloride Cribs.

Waste Disposal Facility	North-South Length (m)	East-West Length (m)	Bottom Area (m ²)	Depth to Water (m)	Average Annual Discharge (L)	Infiltration Rate (L/m ² /day)	Porosity (%)	Column Pore Volume (L)	Total Discharge Volume (L)	% Pore Volume
216-Z-1A	84	35	2,940	57	1.15E+06	1.07	30	5.03E+07	6.21E+06	12
216-Z-9	18.3	9.1	167	57.6	6.08E+05	10.00	30	2.88E+06	4.09E+06	142
216-Z-18	63	12	756	59	9.74E+05	3.53	30	1.34E+07	3.86E+06	29

Table G-7. Estimated Depth of Organic Migration Beneath the Carbon Tetrachloride Cribs (from Rohay et al. 1994a).

Waste Disposal Facility	North-South Length (m)	East-West Length (m)	Bottom Area (m ²)	Depth to Water (m)	Total Organic Discharge (L)	Residual Saturation (%)	Depth of Migration (m)
216-Z-1A	84	35	2,940	57	1.75E+05	2.5	2
216-Z-9	18.3	9.1	167	57.6	8.30E+05 to 3.00E+05	2.5	20 to 72
216-Z-18	63	12	756	59	1.10E+05	2.5	6

Table G-8. Physical Properties of Carbon Tetrachloride (from Last and Rohay 1993).

Property	Units	Pure Carbon Tetrachloride	85% Carbon Tetrachloride, 15% TBP by volume	50% Carbon Tetrachloride, 50% DBBP by volume	50% Carbon Tetrachloride, 50% Lard Oil by Volume	Water
Liquid density	g/mL at 20°C	1.59 ^{b,c}				1.00 ^{b,c}
	g/mL at 25°C		1.51 ^d	1.27 ^d	1.25 ^d	
Absolute viscosity	centipoise at 24°C		5.75 ^d	4.50 ^d	10.50 ^d	
	centipoise at 20°C	0.97 ^{b,c}				1.00 ^b
Interfacial tension with air	dynes/cm at 24°C		31.0 ^d	32.0 ^d	33.0 ^d	
Interfacial tension with water	dynes/cm at 24°C		23 ^d	11 ^d	18 ^d	
	dynes/cm at 20°C	45.0 ^b				
Interfacial tension with 5 M sodium nitrate	dynes/cm at 24°C		11 ^d	19 ^d	7 ^d	
Vapor pressure	cm H ₂ O at 24°C, 30.1 in. Hg	130 ^d	100 ^d	52 ^d	60 ^d	
	25°C	109 ^c				
	20°C	90 ^b				
Saturated vapor concentration	mg/L at 20°C	754 ^a				
	ppmv at 20°C	120,000 ^a				
Saturated vapor density	g/L at 25°C, 1 atm	6.29 ^b				Dry air = 1.204 ^b
Relative vapor density (dry air)	Saturated at 25°C and 1 atm	1.62 ^c				
Relative vapor density (moist air)	Saturated at 20°C and 1 atm	1.51 ^b				
Air diffusion coefficient	cm ² /s at 20°C	0.0797 ^b				
Henry's Law constant	atm-m ³ /mol at 25°C	0.0302 ^b				
		0.0298 ^c				
Solubility in water	mg/L at 20°C, 1 atm	800 ^{a,b}				
Dielectric constant		2.2 ^{a,c}				78.5(a) 80.4(c)

^aRohay and Johnson (1991).

^bCohen et al. (1993).

^cPankow and Cherry (1996).

^dLast and Rohay (1993).

DBBP = dibutyl butyl phosphonate

TBP = tributyl phosphate

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